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ACCIDENTS IN MINES.

Mr. Ellis Lever had a truly appalling story to tell in the *Times* the other day. The number of persons who have been killed by explosions in mines during the past fifty years is 11,000, a fact which is heartrending enough in itself; but Mr. Lever says that this number is only a small proportion of those who have met their deaths by colliery accidents. The number of deaths through accidents of all kinds in mines since the Queen's accession is nearly six times greater—60,000, Mr. Lever says—whilst 4,000,000 persons have been maimed or otherwise injured. Mr. Burt, M.P., an undoubted authority, states that the average number of those killed in mining operations is now 1,200 a year, and that 100,000 persons annually are injured in following the hazardous occupation of the miner. What are the causes which conduce to this terrible loss of human life? Mr. Lever says the want of a better and safer light is mainly responsible. The Royal Commission on Accidents in Mines has condemned as unsafe the lamps of Davy, Clancy, and Stephenson. The House of Commons confirmed the conclusions arrived at by the Royal Commissioners, and Government Inspectors of Mines are now advocating and hoping for the immediate and universal introduction of the electric light into coal mines.

No doubts exist in the minds of those who have most attentively considered the subject, that it is to the electric light that the miner must look for emancipation from many of the horrible dangers to which he is subject. There are many forms of electric lamps now competing for the favour of miners and mine inspectors, and some of them possess undoubted advantages over the older types of safety lamps. But there are also, in most of these, serious drawbacks which prevent their speedy introduction to mine uses. Weight, complication, and cost are amongst the principle disadvantages; and it behoves electricians to give their utmost thought to the task of overcoming the difficulties which the peculiar needs of the miner present. We have it on the testimony of Sir Frederick Abel that very great progress has been made towards providing the miner with a thoroughly safe, sufficiently portable, and generally efficient self-contained electric lamp since the Royal Commission submitted its final report; but the same authority is of opinion that strenuous exertions are yet needed before the comparatively heavy first cost of electric lamps will be so greatly counter-balanced by their durability and simplicity in construction and maintenance as to afford hope of their being generally or even very extensively substituted for oil lamps. So that it is evident that the electrician is, in this direction as in many others, still behind the needs of the age, and behind what is expected of him.

A few words of advice as to what seems to us the most promising path to follow for the purpose of providing a satisfactory miners' lamp may not be out of place. Most claimants to notice in the shape of portable electric lamps are supplied with current by means of primary batteries. There are of course certain advantages with a lamp which will last without replenishment for a great many hours, and which, when exhausted, can be recharged in a short time. But the process of recharging is not so simple that it can be undertaken by the miner himself without danger of derangement or injury to the apparatus, and the necessity of frequently repeating the operation would, if a special staff were retained for the purpose, render it imperative that that staff should be a large and expensive one. Lamps fed by secondary batteries commend themselves to our judgment upon many grounds. They may be recharged when exhausted by the simple act of connecting them with a dynamo machine; the cost of producing current by mechanical means is notably cheaper than by chemical; and the readiness with which a secondary battery adapts itself to the exigencies of moderately rough usage is a very important argument in its favour. The first cost with secondary batteries would be greater, for it would be necessary to provide a double set of batteries, if not of lamps, one set to be undergoing charging whilst the other is in use. But the cost of maintenance would be so much less that in the course of years comparison would be greatly in favour of the secondary battery. The use of the latter form presumes, of course, the presence of a dynamo somewhere in or about the mine. At present very few mines possess an installation of the electric light, but knowledge of the advantages of this system is spreading, and we may anticipate its increasing employment. Whilst introducing a plant for the illumination of the mine mains, the electrical engineer would bear in mind the secondary object of providing current for the portable lamps, and would arrange his machinery accordingly. But even where no electric light machinery exists, there would be little difficulty in introducing a small dynamo for the special purpose of charging the miner's lamps.

It is satisfactory, seeing the pressing need for a more suitable lamp for use in mines, to learn from Sir Frederick Abel that the fulfilment of all reasonable conditions imposed by the mining public is at the present time occupying the best energies of very competent practical electricians; that extensive trials, underground, of some of the most promising of existing electric hand lamps are already in progress, and that others of a still more extensive nature are in preparation. We wish our friends speedy and complete success.

BEING desirous of getting some practical information respecting the water motor of Mr. Sealy Allin, which we described last week, we communicated with Messrs. Simmons and Gifford, of Winchester, who have been using a motor for the past 15 months in their mills constructed to develop 18 horse-power. It is employed, amongst other purposes, for driving a dynamo, and with a heavy load of from 10 to 15 H.P.

it is found to run very steadily and well. Messrs. Simmons and Gifford think that its slow speed is a drawback when considered as an electric lighting motor only, but notwithstanding this they consider it efficient for the purpose, for with a moderately heavy load and an even head of water it does not run off at an increased speed, as many other water-motors are apt to do, to the detriment of the dynamo. Of course no governor is necessary, and the percentage of power yielded is said to be very good. On this latter point we should like to get precise data, but from the foregoing particulars with which the Winchester firm has courteously supplied us, we think Mr. Sealy Allin may rest assured that his motor has a good future in store for it.

THE transformer system is having rather an unfortunate experience in this country. Whatever may have been its success elsewhere, it has certainly so far not proved trustworthy enough to induce a feeling of security in its use. It is a sad reflection upon electric lighting that Mr. Terry's new theatre was, after all, opened with gas in full glare. The explanation given was that "the engine at the Grosvenor Gallery" had broken down, and that every theatre supplied by Sir Coutts Lindsay and Company was in the same predicament that evening. Failures of this sort, whatever the cause, have an unmeasurable influence in shaking the growing faith of the public in the electric light. It is evident, as we have before pointed out, that no method equals that which includes the use of secondary batteries to provide current and prevent the collapse of the lighting when a breakdown occurs with the engine or dynamo.

WE learn from a Paris contemporary that the action brought against the Paris-New York Telegraph Company (Pouyer-Quertier) by the associated Atlantic cable companies, before the Commercial Tribunal of the Seine, has been postponed for a fortnight. Our readers will remember that on the 31st of last December the French company—acting, it is said, under the influence of the Mackay-Bennett Company—repudiated its agreement with the Anglo-American and the Direct United States companies. We understand that the damages claimed by these associated companies amount to about six million francs, which sum they claim is due to them according to the mutual agreement. Rumours seem to confirm the report that to the Paris-New York Telegraph Company is due the resuscitation of the Antilles cables scheme. The conception is not wanting in boldness, for it is intended by means of these cables to prolong the French Atlantic Company's system to Brazil. It is not to be wondered at, however, that general opinion is unfavourable as to the financial success of the undertaking. Count Dillon, who was ousted in 1881 from the French Atlantic Company in consequence of disagreements with his colleagues, MM. Pouyer-Quertier, Riaut, &c., will take the direction of the new combination, having been re-installed as manager and director-general of the Pouyer-Quertier Company. The first section of the Antilles cables, which will be laid between Santiago de Cuba and some point in Hayti or Santo Domingo, is being manufactured at the works of the Société Générale des Téléphones. The *Bulletin des Sociétés d'Electricité* states that although the English Government has pronounced against the prolongation of the monopoly held by the Submarine Telegraph Company (granted in 1851 and lapsing in 1889), yet the French Government is on the point of granting a renewal of this monopoly for 15 years. Our contemporary protests against the action of the French Government in the matter, as the course proposed cannot be otherwise than prejudicial to public interests. Judging from the complaints which from time to time have been made on the other side of the Channel, as to the absence of any inclination on the part of the Submarine Company to meet with the constantly increasing demands for through lines or direct cables between certain of the principal French and English ports, the protest appears to be well founded. It certainly seems to us that were all monopoly abolished the Submarine Company would in self defence be compelled to take such steps as might be necessitated by the public demand for increased facilities of communication. At all events, the monopoly should be renewed only with conditions guaranteeing public satisfaction.

THE *Financial News* reports a meeting of the Water Primary Battery Company, Limited, held on the 13th inst., at which M. d'Humy was duly introduced to the shareholders as a gentleman possessing one of the most inventive minds in Europe. We were amongst the first to discover in this inventor the signs of mighty genius, and we should be the last to immolate on the altar of prejudice the creations of a master mind; but we have been compelled to treat the water battery with some ridicule, firmly believing that any individual influenced by the extravagant demands of M. d'Humy on his credulity, could not be reached by ordinary reason. As may be seen from our Correspondence columns, it seems that M. d'Humy is not well pleased with the remarks which we have made from time to time on the battery which he has invented, or, rather, disinterred from the grave of the past, and we are truly unfortunate in having incurred the ire of so sanguine an inventor. But it is our fortune or misfortune to be continually in the same plight. We have no sooner settled one enthusiast than another starts up; and we beg to assure M. d'Humy that whenever we find ignorance misleading, as we think, a too-confiding public or a too gullible directorate, we shall make it our duty to call immediate attention to the fact. The Water Primary Battery Company, in causing to be published reports unprecedented in character, has courted public criticism; and believing as we do that our prior remarks were fully justified, it is our duty and our privilege to say so distinctly and emphatically. We do not care how many concessions the inventor may have obtained, or how many orders he may have on hand. If the facts relating to these are as he states they become explicable only on the basis of Carlyle's famous dictum respecting the population of Great Britain, which as regards things electrical we heartily endorse.

THE dynamo of Mr. Charles Lever, which figures in our other pages, is said to possess the advantages of reduction of air space resistance and a greater facility for the passage of the magnetic lines of force through the armature. The latter point may be correct in one way, but it appears to us that the lines of force do not pass in the manner which is most advantageous for the conductor which surrounds the armature. We may be incorrect in this, but, from a casual glance at the construction of the machine, we can come to no other conclusion. Perhaps Mr. Lever is not aware that the late Richard Werdermann constructed a dynamo with grooved pole-pieces; and surely, if our memory serves us, Mr. Mordey has patented something of a like nature.

MODERN VIEWS OF ELECTRICITY.*

By PROF. OLIVER J. LODGE, in *Nature*.

PART I.—I.

IT is often said that we do not know what electricity is, and there is a considerable amount of truth in the statement. It is not so true, however, as it was some twenty years ago. Some things are beginning to be known about it; and though modern views are tentative, and may well require modification, nevertheless some progress has been made. I shall endeavour in this lecture to set forth as best I may the position of thinkers on electrical subjects at the present time.

It will at once strike you that the whole subject of electricity as at present known is too gigantic for anyone to make an attempt to compass it in a single lecture, even though he assume on the part of his audience a perfect acquaintance with all the ordinary phenomena; and you will admit that it is much better to limit one's self definitely at the beginning to some one branch than by attempting too broad and discursive a survey to risk slurring the whole and becoming totally unintelligible.

I begin by saying that the whole subject of electricity is divisible for purposes of classification into four great branches.

1. Electricity at rest, or static electricity: wherein are studied all the phenomena belonging to stresses and strains in insulating or dielectric media brought about by the neighbourhood of electric charges or electrified bodies at rest immersed therein; together with the modes of exciting such electric charges and the laws of their interactions.

2. Electricity in locomotion, or current electricity: wherein are discussed all the phenomena set up in metallic conductors in chemical compounds, and in dielectric media, by the passage of electricity through them; together with the modes of setting electricity in continuous motion and the laws of its flow.

3. Electricity in rotation, or magnetism: wherein are discussed the phenomena belonging to electricity in whirling or vortex motion, the modes of exciting such whirls, the stresses and strains produced by them, and the laws of their interaction.

4. Electricity in vibration, or radiation: wherein are discussed the propagation of periodic or undulatory disturbances through various kinds of media, the laws regulating wave velocity, wave length, reflection, interference, dispersion, polarisation, and a multitude of phenomena studied for a long time under the heading "Light." Although this is the most abstruse and difficult portion of electrical science, a certain fraction of it has been known to us longer than any other branch, and has been studied under special advantages, because of our happening to possess a special sense-organ for its appreciation.

Now, with some qualms of regret I have decided to refrain from speaking to you about any one of these great and comprehensive groups except the first. It is hopeless to attempt more: and even the small portion of that on which I shall touch will tax the time at our disposal to the utmost, and I must assume acquaintance with the elementary facts in order to proceed to their elucidation.

The great names in connection with our progress in knowledge as to the real nature of electricity, irrespective of a mere study and extension of its known facts, are

FRANKLIN, CAVENDISH, FARADAY, MAXWELL.

To these, indeed, you may feel impelled to add the tremendous name of THOMSON; but one has some delicacy in attempting to estimate the work of living philosophers, and as Maxwell has been very explicit in acknowledging his indebtedness to his illustrious contemporary, whose work will in the course of nature have to be criticised and appraised by far abler hands than mine and by the philosophers of generations yet unborn, we may well afford to abstain from minute considerations and accept for the present the name of Maxwell as representative of the great English school of mathematical physicists, under whose influence, Cambridge, in the pride of having reared them, is awaking to new and energetic scientific life, and whose splendid achievements will shine out in the future as the glory of this century.

The views concerning electrification which I shall try to explain are in some sense a development of those originally propounded by that most remarkable man, Benjamin Franklin. The accurate and acute experimenting of Cavendish laid the foundation for the modern theory of electricity; but, as he worked for himself rather than for the race, and as moreover he was in this matter far in advance of his time, Faraday had to go over the same ground again, with extensions and additions peculiar to himself and corresponding to the greater field of information at his disposal three-quarters of a century later. Both these men, and especially Faraday, so lived among phenomena that they yielded up their hidden secrets to them in a way unintelligible to ordinary workers; but while they themselves arrived at truth by processes that savour of intuition, they were unable to express themselves intelligibly to their contemporaries and to make the inner meaning of their facts and speculations understood. Then comes Maxwell with his keen penetration and great grasp of thought combined with mathematical subtlety and power of expression; he assimilates the facts, sympathises with the philosophic but untutored modes of expression invented by Faraday, links the theorems of Green and Stokes and Thomson to the facts of Faraday, and from the union there arises the young modern science of electricity, whose infancy at the present time is so vigorous and so promising that we are all looking forward to the near future in eager hope and expectation of some greater and still more magnificent generalisation.

You know well that there have been fluid or material theories of electricity for the past century; you know, moreover, that there has been a reaction against them. There was even a tendency a few years back to deny the material nature of electricity and assert its position as a form of energy. This was doubtless due to an analogical and natural, though unjustifiable, feeling that just as sound and heat and light had shown themselves to be forms of energy so in due time would electricity also. If such were the expectation, it has not been justified by the event. Electricity may possibly be a form of matter—it is not a form of energy. It is quite true that electricity *under pressure* or *in motion* represents energy, but the same thing is true of water or air, and we do not therefore deny them to be forms of matter. Understand the sense in which I used the word electricity. *Electrification* is a result of work done, and is most certainly a form of energy; it can be created and destroyed by an act of work. But electricity—none is ever created or destroyed, it is simply moved and strained like matter. No one ever exhibited a trace of positive electricity without there being somewhere in its immediate neighbourhood an equal quantity of negative.

This is the first great law, expressible in a variety of ways: as, for instance, by saying that total algebraic production of electricity is always zero; that you cannot produce positive electrification without an equal quantity of negative also; that what one body gains of electricity some other body must lose.

Now, whenever we perceive that a thing is produced in precisely equal and opposite amounts, so that what one body gains another loses, it is convenient and most simple to consider the thing not as generated in the one body and destroyed in the other, but as simply *transferred. Electricity in this respect behaves just like a substance.* This is what Franklin perceived.

The second great law is that electricity always, under all circumstances, flows in a closed circuit, the same quantity crossing every section of that circuit, so that

* Expansion of a lecture delivered by Dr. Oliver Lodge, partly at the London Institution on January 1st, 1885, and partly at the Midland Institute, Birmingham, November 15th, 1886, but not hitherto published.

it is not possible to exhaust it from one region of space and condense it in another.

Another way of expressing this fact is to say that no charge resides in the interior of a hollow conductor.

Another is to say that total induced charge is always equal and opposite to inducing charges.

[This is illustrated by the well-known experiment of insulating and charging a parrot cage with a sensitive electroscope inside connected to its wires: also by the ice-pail experiment.]

When we thus find that it is impossible to charge a body absolutely with electricity, that though you can move it from place to place it always and instantly refills the body from which you take it, so that no portion of space can be more or less filled with it than it already is, it is natural to express the phenomenon by saying that electricity behaves itself like a perfectly *incompressible* substance or fluid, of which all space is completely full. That is to say, it behaves like a perfect and all-permeating *liquid*. Understand, I by no means assert that electricity *is* such a fluid or liquid; I only assert the undoubted fact that it behaves like one, *i.e.*, it obeys the same laws.

It may be advisable carefully to guard one's self against becoming too strongly imbued with the notion that because electricity obeys the laws of a liquid therefore it is one. One must always be keenly on the look-out for any discrepancy between the behaviour of the two things, and a single certain discrepancy will be sufficient to overthrow the fancy that they may perhaps be really identical. Till such a discrepancy turns up, however, we are justified in pursuing the analogy—more than justified, we are impelled. And if we resist the help of an analogy like this there are only two courses open to us; either we must become first-rate mathematicians, able to live wholly among symbols and dispensing with pictorial images and such adventitious aid; or we must remain in hazy ignorance of the stages which have been reached, and of the present knowledge of electricity so far as it goes. I need hardly say that by "modern views" I do not mean *ultimate* views; nor do I mean that I can give an account of all the speculations and ideas floating in the minds of some two or three of our most advanced thinkers. All I attempt is to give an account of the stage which has certainly been attained, and to ask you to take for granted that the next quarter of a century will see as great advances made upon these views as they are superior to the doctrines inculcated by the ordinary run of text-books.

Imagine now that we live immersed in an infinite ocean of incompressible and inexpansible all-permeating perfect liquid, like fish live in the sea, and how can we become cognisant of its existence? Not by its weight, for we can remove it from no portion of space in order to try whether it has weight.

We can weigh air, truly, but that is simply because we can compress it and rarefy it. An exhausting or condensing pump of some kind was needed before even air could be weighed or its pressure estimated.

But if air had been incompressible and inexpansible, if it had been a vacuumless perfect liquid, pumps would have been useless for the purpose, and we should necessarily be completely ignorant of the weight and pressure of the atmosphere.

How then should we become cognisant of its existence? In four ways:—

(1) By being able to pump it out of one elastic bag into another [not out of one bucket into another: if you lived at the bottom of the sea you would never think about filling or emptying buckets—the idea would be absurd; but you could fill or empty elastic bags], and by noticing the strain phenomena exhibited by the bags and their tendency to burst when over full. [Water (or air) was here pumped out of one elastic bag into another, and the analogy with an electrical machine charging two conductors oppositely was pointed out.]

(2) By winds or currents; by watching the effect of moving masses of the fluid as it flows along pipes or through spongy bodies, and by the effects of its inertia and momentum. [A hanging vane in a tube deflected by a stream of water was here likened roughly to a galvanometer; also the effect of suddenly stopping a stream of water, as in a water ram, was mentioned as analogous to self-induction.]

(3) By making vortices and whirls in the fluid, and by observing the mutual action of these vortices, their attractions and repulsions. [Whirlwinds, sand storms, waterspouts, cyclones, whirlpools.]

(4) By setting up undulations in the medium: *i.e.*, by the phenomena which in ordinary media excite in us through our ears the sensation called "*sound*."

In all these ways we have become acquainted with electricity, and in no others that I am aware of. They correspond to the four great divisions of the subject which I made above. But there are differences, very important differences, between the behaviour of a material liquid ocean such as we have contemplated and the behaviour of electricity. First, it is doubtful whether electricity by itself and disconnected from matter, has any inertia. It is by no means certain that it has not: the experiments made by Maxwell with a negative result need only prove either that its speed of flow is very small, or that an electric current consists of equal opposite streams of equal momentum, The laws of electric flow in conductors are such as indicate no inertia, and this fact would be conclusive were it not that a recent brilliant paper by Prof. Poynting explains the reason of it completely otherwise, and leaves the question of inertia quite open; on the other hand, the facts of magnetism seem definitely to require inertia, or something corresponding to it. Leaving this therefore as an open question, there can be no doubt but that when in connection with insulating or dielectric matter *the combination* most certainly possesses inertia.

A more serious and certain difference between the behaviour of electricity and that of an incompressible fluid comes out in the fourth category—that concerned with wave-motion. In an incompressible fluid the velocity and length of waves would both be infinite, and none of the phenomena connected with the gradual propagation of waves through it could exist. Such a medium therefore would be incapable of sound vibrations in any ordinary sense. On the other hand, it is quite certain that the disturbances concerned in light radiation take place at right angles to the direction of propagation—they are transverse disturbances—and such disturbances as these no body with the entire properties of a fluid can possibly transmit. Remember, however, that the medium which transmits light is the ether and not simply electricity. We have nowhere asserted that electricity and the ether are identical. If they are, we are bound to admit that ether, though fluid in the sense of enabling masses to move freely through it, has a certain amount of rigidity for enormously rapid and minute oscillatory disturbances. If they are not identical, we can more vaguely say that ether contains electricity as a jelly contains water, but that the rigidity concerned in the transverse vibrations belongs not to the water in the jelly but to the mode in which it is entangled in its meshes. However, all this is a great and difficult question into which we shall be able to enter with more satisfaction twenty years hence.

Provisionally, we will accept as a working hypothesis the idea of the ether consisting of electricity in a state of entanglement similar to that of water in jelly; and we are driven to this view by the exigencies of mode I, the electrostatic or strain method of examining the properties of electricity, because otherwise the properties of insulators are hard to conceive. If it turn out that space is a conductor, which seems to me highly improbable, then we must fall back upon the other view that it is rigid only for infinitesimal vibrations, and fluid for steady forces.

Return now to the consideration of electrostatics. We are to regard ourselves as living immersed in an infinite all-permeating ocean of perfect incompressible fluid (or liquid), as fish live in the sea; but this is not all, for if that were our actual state we should have no more notion of the existence of the liquid than deep-

sea fish have of the medium they swim in. If matter were all perfectly conducting, it would be our state: in a perfectly free ocean there is no insulation—no obstruction to flow of liquid: it is the fact of insulation that renders electrostatics possible. We could obstruct the flow and store up definite quantities of a fluid in which we were totally submerged by the use of closed vessels, of course. But how could we pump liquid from one into another so as to charge one positively and another negatively? Only by having the walls elastic: by the use of elastic bags, and elastic partitions across pipes. And so we can represent a continuous insulating medium (like the atmosphere or space) by the analogy of a jelly, through which liquid can only flow by reason of cracks and channels and cavities.

Modify the idea of an infinite ocean of liquid into that of an infinite jelly or elastic substance in which the liquid is entangled, and through which it cannot penetrate without violence and disruption; and you have here a model of the general insulating atmosphere. Our ocean of fluid is not free and mobile like water, it is stiff and entangled like jelly.

Nevertheless, bodies can move through it freely. Yes, *bodies* can, it is the *liquid* itself only which is entangled. How we are to picture freely and naturally the motion of ordinary matter through the insulating medium of space it is not easy to say. It is a difficulty not fatal but sensible, and due to an imperfection in our analogy.

Insulators being like elastic partitions or impervious but yielding masses, conductors are like cavities, porous or spongy bodies perfectly pervious though with more or less frictional resistance to the flow of liquids through them. Thus, whereas bodies easily penetrable by matter are impervious to electricity, bodies like metals which resist entirely the passage of matter, are quite permeable to electricity. It is this inversion of ordinary ideas of penetrability that constitutes a small difficulty at the beginning of the subject.

However, supposing it overcome, let us think of these insulated spheres and cylinders on the table connected by copper wire as so many cavities and tubes in an otherwise continuous elastic impervious medium which surrounds them and us, and extends throughout space wherever conductors are not. All, however, cavities as well as the rest of the medium, are completely full of the universal fluid. The fluid which is entangled in insulators is free to move in conductors; whence it follows that its pressure or potential is the same in every part of a conductor in which it is not flowing along. For if there were any excess of pressure at any point, a flow would immediately occur until it was equalised. In an insulator this is by no means the case. Differences of pressure are exceedingly common in insulators, and are naturally accompanied by a strain of the medium.

[Here certain electrostatic experiments were shown as evidence of the strain existing at the ends of a long insulated wire connected to a Voss machine.]

There have been, as you know, two ancient fluid theories of electricity—the one-fluid theory of Franklin, and the two-fluid theory of Symmer and others. A great deal is to be said for both of them within a certain range. There are certainly points, many points, on which they are hopelessly wrong and misleading, *but it is their foundation upon ideas of action at a distance that condemns them, it is not the fluidity.* They concentrate attention upon the conductors; whereas Faraday taught us to concentrate attention on the insulating medium surrounding the conductors—the "*dielectric*" as he termed it. This is the seat of all the phenomena: conductors are mere breaks in it—interrupters of its continuity.

To Faraday the space round conductors was full of what he called lines of force; and it is his main achievement in electrostatics to have diverted our attention from the obvious and apparent to the intrinsic and essential phenomena. Let us try and seize his point of view before going further. It is certainly true as far as it goes, and is devoid of hypothesis.

Take the old fundamental electric experiment of rubbing two bodies together, separating them, and exhibiting the attraction and repulsion of a pith ball, say, and how should we now describe it? Something this way.

Take two insulated discs of different material, one metal, say, and one silk, touch them together, the contact effects a transfer of electricity from the metal to the silk: rub slightly to assist the transfer, since silk is a non-conductor, then separate. As you separate the discs the medium between them is thrown into a state of strain, the direction of which is mapped out by drawing a set of lines, called lines of force, from one disc to the other, coincident with the direction of strain at every point. As Faraday remarked, the strain is as if these lines were stretched elastic threads endowed with the property of repelling each other as well as of shortening themselves; in other words, there is a tension along the lines of force and a pressure at right angles to them. When the discs are near, and the lines short, they are mainly straight, fig. 1, but as the distance increases they become curved, bulging away from the common axis of the two discs, and some even curling round to the back of the disc (fig. 2), until when the discs are infinitely distant as many lines spring from the back of each as from its face; and we have a charged body to all intents existing in space by itself.

FIG. 1.

Rough diagram of the state of the medium near two oppositely charged discs when close together.

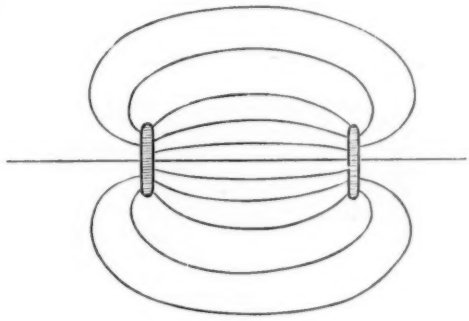


FIG. 2.

Rough diagram of the state of the medium near two oppositely charged discs when separated.

The state of tension existing in the medium between the discs results in a tendency to bring them together again, just as if they were connected by so many elastic threads of no length when unstretched. The ends of the lines are the so-called electrifications or charges, and the lines perpetually try and shorten and shut up, so that their ends may coincide and the strain be relieved. If one of the discs touch another conducting body, some of its lines instantly leave it and go to the body; in other words, the charge is capable of transference, and the new body is urged toward the other disc, just as the disc was from which it received the lines. If this new body *completely surrounds* the disc, it receives the whole of its lines, and the disc can be withdrawn perfectly free and inert. [Faraday's "ice-pail" experiment.]

Now take the two charged discs, facing one another, and let, say, a suspended gilt pith ball hang between them. Being a conductor there is no strain inside it, and so it acts partially as a bridge, and several of the lines pass through it—or, rather, they end at one side of it and begin at the other: thus it has opposite charges on its two faces—it is under induction (fig. 3).

Let it now be moved so as to touch one of the discs, the lines between it and the disc on that side have shut up, and it remains with those only which go to the other disc. In other words, it has received some lines from the touched disc. These will pull it over to the far disc and there shut themselves up. From that disc it receives more, and travels with their ends back to

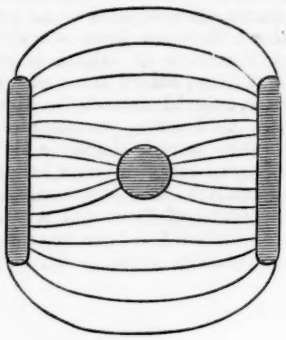


FIG. 3.

Rough diagram of the medium between two discs disturbed by the presence of an uncharged metal sphere. The two halves of the sphere are oppositely charged "by induction."

the first disc, and so on (fig. 4), perpetually receiving lines and shutting them up until they are all gone and the discs are discharged.

This mode of stating the facts involves no hypothesis whatever—it is the simple truth. But the "lines of force" have no more and no less existence than have "rays of light." Both are convenient modes of expression.

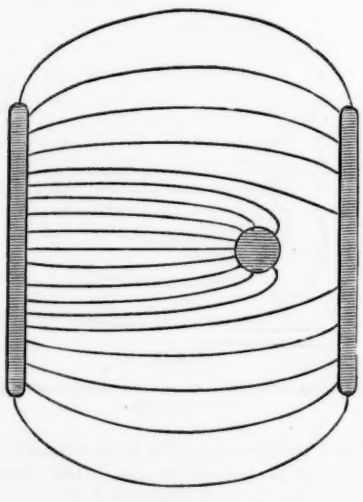


FIG. 4.

Rough diagram of the medium near two oppositely charged discs between which a metal carrier ball is oscillating, having just touched the right-hand disk. (Discharge by "alternate contact.")

But so long as we adhere to this mode of expression we cannot form a complete mental picture of the actually occurring operations. In optics it is usual to abandon rays at a certain stage and attend to the waves, which we know are of the essence of the phenomenon, though we do not know yet very much about their true nature.

Similarly in electricity, at a certain point we are led to abandon lines of force and potential theories, and to try to conceive the actual stuff undergoing its strains and motions. It is then we get urged towards ideas similar to those which are useful in treating of the behaviour of an incompressible fluid.

In an utterly modified sense, we have still a fluid theory of electricity, and a portion of the ideas of the old theories belong to it also.

Thus Franklin's view that positive charge was excess and negative charge was a deficit in a certain standard quantity of the fluid which all bodies naturally possessed in their neutral state, remains practically true. His view that the fluid was never manufactured, but was taken from one body to give to another, so that one gained what the other lost—no more and no less—remains practically true. Part also—a less part—of the two-fluid theory likewise remains true, in my present opinion; but this is not a branch of the subject on which I shall enter in the present discourse. It will suffice for the present to fix our attention on one fluid only.

You are to think of an electric machine as a pump which, being attached to two bodies respectively, drives some electricity from the one into the other, conferring upon one a positive and upon the other a precisely equal negative charge. One of the two bodies may be the earth, in which case the charge makes little or no difference to it.

But, as has been objected before, if electricity is like an incompressible and inextensible fluid, how is it possible to withdraw any of it from one body and give it to another? With rigid bodies it is not possible, but with elastic bodies it is easy.

The act of charging this sphere is therefore analogous to pumping water into this elastic bag, or rather into a cavity in the midst of an elastic medium, whose thick walls, extending in all directions and needing a great pressure to strain them, better represent the true state of the case than does the thin boundary of a bag like this.

Draw a couple of such cavities and consider fluid pumped from one into the other, and you will see that the charge (*i.e.*, the excess or defect of fluid) resides on the outside. You may also show that when both are similarly charged the medium is so strained that they tend to be forced apart; whereas when one is distended and the other contracted they tend to approach.

Further you may consider two cavities side by side, pump fluid into (or out of) one only, and watch the effect on the other. You will thus see the phenomena of induction, the near side of the second cavity becoming oppositely charged *i.e.*, the walls encroaching on the cavity), the far side similarly charged (the cavity encroaching on the walls), and the pressure on the fluid in the cavity being increased or diminished in correspondence with the change of pressure in the charged or inducing cavity. In other words, conductors rise in potential when brought near a positively charged body.

The actual changes in volume necessary to the strain of these cavities are a defect in the analogy. To avoid this objection, one will have to accept a dual view of electricity—a sort of two-fluid theory, which many phenomena urge one to accept, but about which I will say nothing to-night. It is sufficient at first to grasp the one-fluid idea.

Return Circuit.—Sometimes a difficulty is felt about electricity flowing in a closed circuit—as, for instance, in signalling to America and using the earth as a return circuit: the question arises, How does the electricity find its way back?

The difficulty is no more real than if a tube were laid to America with its two ends connected to the sea and already quite full. If now a little more sea-water were pumped in at one end, an equal quantity would leave the other end, and the disturbed level of the ocean would readjust itself. Not the same identical water would return, but an equal quantity would return. That is all one says in electricity. One cannot label and identify electricity.

To imitate the inductive retardation of cables, the tube should have slightly elastic walls; to imitate the speed of signalling, the water must be supposed quite incompressible, not elastic as it really is, or each pulse would take three-quarters of an hour to go.

Condensers.—Returning to the subject of charging bodies electrically, how is one to consider the fact that bringing an earth-plate near a conductor increases its capacity so greatly, enabling the same pressure to force

in a much larger quantity of fluid? how is one to think of a condenser, or Leyden jar?

In the easiest possible way, by observing that the bringing near an earth-connected conductor is really *thinning down the dielectric* on all sides of the body.

The thin-walled elastic medium of course takes less force to distend it a given amount than a thick mass of the same stuff took. A Leyden jar is like a cavity with quite thin walls—in other words, it is like an elastic bag.

But if you thin it too far, or strain it too much, the elastic membrane may burst: exactly, and this is the disruptive discharge of a jar, and is accompanied by a spark. Sometimes it is the solid dielectric which breaks down permanently. Ordinarily it is merely the air; and, since a fluid insulator constitutes a self-mending partition, it is instantaneously as good as new again.

There are many things of interest and importance to study about a Leyden jar. There is the fact that if insulated, it will not charge: the potential of both inner and outer coatings rises equally; that, in order to charge it, for every positive spark you give to the interior an equal positive spark must be taken from the exterior. There is the charging and the discharging of it by alternate contacts, as by an oscillating ball; and there are the phenomena of the spark discharge itself.

But, as you know, *all* charging is really a case of a Leyden jar. The outer coat must always be somewhere—the walls of the room, or the earth, or something—you always have a layer of dielectric between two charges—the so-called induced and the inducing charge. You cannot charge one body alone.

To illustrate the phenomena of charge, I will now call your attention to these diagrams—which less completely but more simply than hydraulic illustrations, serve to make the nature of the phenomena manifest.

(To be continued.)

THEILER'S PORTABLE TELEPHONE.

THE object of this invention is to combine the transmitter with the receiver in such a manner that the two parts constitute a single, convenient, and easily portable instrument which will transmit as well as receive speech when held to the ear, requiring no shifting from that position for transmitting nor requiring the speaker to direct his voice towards any particular object.

The apparatus, as shown by fig. 1, consists of a small drum or cylinder, N, of metal or ebonite, closed at one end by the tympan, A, of the transmitter, and at the other end by the tympan, B, of the receiver. A screwed cover, P, with a central aperature, *p*, and of the usual cup shape protects the receiver tympan and permits of the latter being held close to the ear.

Into the cover plate, R, of the opposite or transmitter tympan is inserted a tube or cone, W, having a polished or smooth interior surface and of such a shape that it collects and concentrates the sound waves from the speaker's voice upon the transmitter tympan without inconveniencing the speaker in any way, at the same time serving as a handle to the instrument.

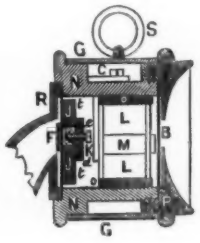
The shape of this cone or tube is of great importance, and that shown in the fig. has only been arrived at after many experiments.

It will be seen that the opening, V, of the said cone is not placed in front or across the speaker's mouth when in use, but at the side. By this means inconvenience to the user and the objectionable condensation of his breath upon the cone is avoided.

It will be further seen that the sound waves impinge only upon the outer curve of the cone and would be conveyed to the tympan, A, by that curve alone. Therefore a row of holes, C^1, C^2, C^3, C^4, does not interfere with, but on the contrary, assists the clear transmission of the sound waves along the cone, W.

Fig. 2 shows a tranverse section of the combined receiver and transmitter, omitting, however, the tube or cone just described and shown in fig. 1. In order to get the receiver into a small space, the inventor constructs it with a circular permanent magnet, O, one pole of which induces the iron core, M, inserted into the coil or helix, L. The other poles induces the thin steel or iron tympan, B.

FIG. 2.



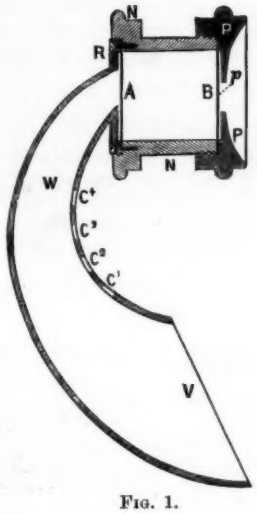


FIG. 1.

The transmitting part of the combination telephone is constructed as follows:—A is a very thin tympan of steel or other highly elastic material firmly clamped between the edge of the box, N, and the cover plate, R. To the centre of this tympan a thin carbon disc, F, is fastened constituting one of the electrodes of a battery circuit. To the back of this tympan is glued a disc, J, of felt or other spongy material with a hole, *e*, in its centre, which hole or chamber is filled with hard carbon granules and closed by another thin steel or other elastic disc to which a weight, *d*, is fixed, constituting the other electrode. A screw, K, traverses the weight, *d*, and enters the chamber, *e*, to reduce the distance, and consequently the electrical resistance between the two electrodes *d* and F.

THE LEVER DYNAMO AND ARC LAMP.

THIS machine differs from others in that the armature has projecting teeth which revolve in grooves in the pole pieces. Fig. 1 shows the armature, and fig. 2 one of the grooved pole pieces. By increasing the surface of the iron of the armature, the magnetic resistance of the air space is reduced, and a greater facility offered for the flow of lines of force through the armature. The grooves in the pole pieces are made in the same machine which bores them out. Fig. 3 shows the dynamo complete. It occupies very little floor space. The field magnets are massive and are sufficiently powerful to completely overmaster the armature. There is hardly any lead to the brushes, and, when giving off current, there is an entire absence of sparking at the commutator. The dynamo has a high efficiency of conversion.

The following are the results of tests made, at Messrs. Blakey-Emmott's works, Halifax, on a small Lever dynamo (the first constructed), series wound. Speed, 1,550; E.M.F., 210 volts; current, 11 ampères; resistance of armature, having a diameter of 8 inches and $7\frac{1}{2}$ inches long, wound with 36 sections, 1·31 ohms; resistance of field magnet coils, ·84 ohms. Mr. Lever hopes to reduce the armature resistance very much in later machines of this type.

The new type of lamp (illustrated) has a solenoid instead of the electro-magnet in the older type. No glycerine is required. The solenoid plunger fits nicely, but freely, inside the brass spool of the solenoid, and when it descends a slight compression of air takes place within the spool. A brass link connects the plunger with the lever. The lever is free to move on a pin fixed in the upright arm of the lamp casting or frame. A spring held by another pin, and adjustable by a nut on the lever at the other end, serves to lift up the lever in its normal condition. The hollowed clutch is supported by its arms in two sleeves, one fixed to the lamp frame, and the other movable with the lever. The upper carbon holder slides freely through bearings in the lamp frame, and is protected by an outer brass tube screwed to a bush at the top of the frame, by means of which the lamp is suspended. The thin copper brush, shown in the illustration, transmits the current to the movable carbon holder. In working, the lamp feeds so gently that it is only by the most careful attention that this can be seen, and it will give a very steady light with cheap American carbons, thus reducing the cost of working to a minimum.

The automatic cut-out, shown on the farther side of the illustration, is very simple. It consists of an electro-magnet wound with two layers of coarse wire, one end being connected to the magnet core, and the other through the resistance strip and to negative

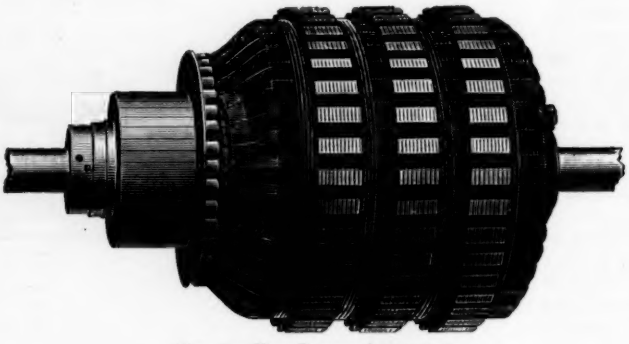


FIG. 1.—THE LEVER ARMATURE.

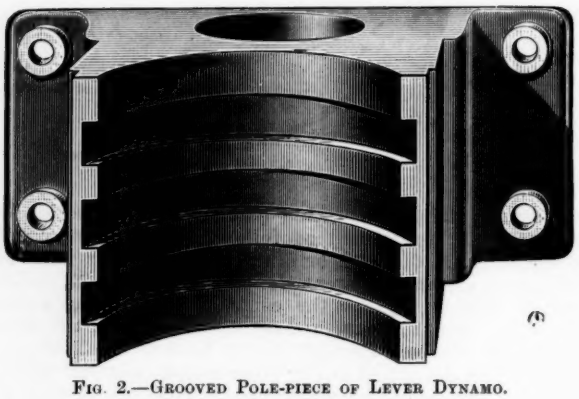


FIG. 2.—GROOVED POLE-PIECE OF LEVER DYNAMO.

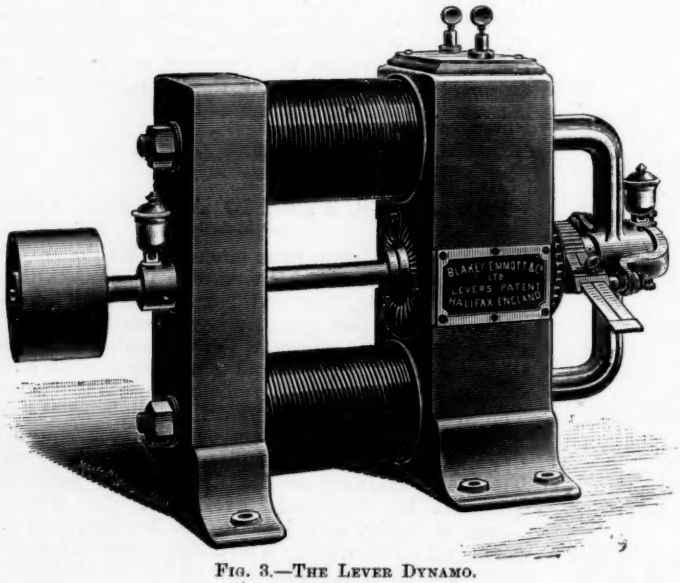
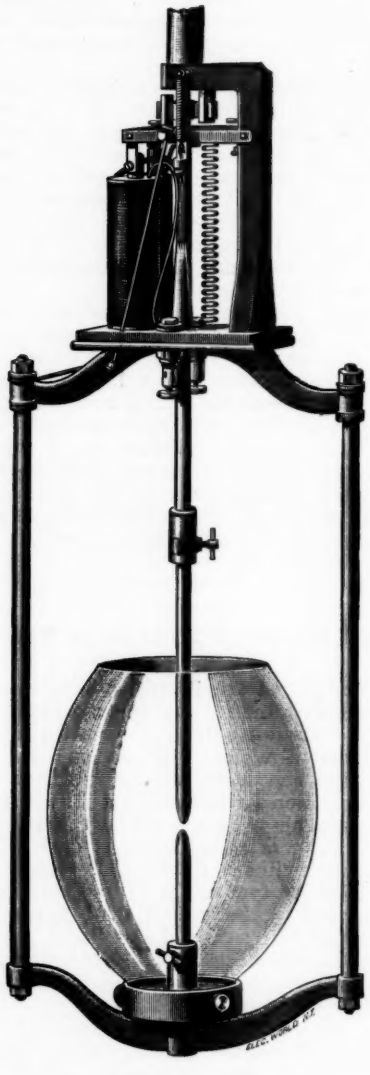


FIG. 3.—THE LEVER DYNAMO.



LEVER ARC LAMP.

terminal. The magnet core is insulated from the frame. A flat headed iron screw, passing through the lever, comes over the magnet pole, but is so adjusted that it will not touch the magnet core until the solenoid has drawn the lever past its feeding point, which it would do if the upper carbon holder sticks. In this case the solenoid would bring the flat headed screw in contact with the magnet core. The lamp would then be cut out, and the current would pass through magnet core, its two coils, the resistance and to negative terminal. The cut-out magnet would hold down the lever so long as the lamp failed to feed, but should the upper carbon holder descend and bring the carbons into contact again, the spring will overpower the cut-out magnet, the lever will be drawn up, and the arc re-struck.

The lamp is automatic in all its operations. The small slanting brass wire attached to the lever is used in trimming the lamp when the case is on. By pulling the little knob at the left-hand side, underneath the frame, the lever is lowered and the top carbon holder is released.

THE ELECTROMOTIVE FORCE OF MAGNETISATION.*

By EDWARD L. NICHOLS and WILLIAM S. FRANKLIN, of the University of Kansas.

IF two electrodes of iron or steel be submerged in a liquid capable of dissolving iron, and their free ends be connected metallically, permanent electric currents will be developed in the voltaic circuit thus formed whenever the magnetic condition of the electrodes differs or whenever they are situated in magnetic fields of unequal intensity. The electromotive force to which these currents are due we propose to call, for want of a better name, *the electromotive force of magnetisation.* At least two quite distinct effects are comprised under this term :—

(*a*). That produced by magnetisation of one electrode. To this effect it is not essential that the reaction between the iron and the liquid take place within the magnetic field.

(*b*). That produced when the reaction between the iron of one electrode and the liquid takes place within the magnetic field.

The currents due to effect (*a*) have been investigated by Dr. Theodor Gross.† The consideration of the influence of the magnetic field upon the chemical behaviour of iron‡ has led the present authors to the discovery of effect (*b*).

As the result of a variety of experiments which were tried to determine the laws of the formation of these currents, the following points have been established :—

1. The E.M.F. in question is not that due to structural changes in the magnetised electrode.

2. It is not that due to magnetisation merely, but depends upon the reaction between the iron and the liquid taking place *within the magnetic field.*

3. The E.M.F. between the electrode acted upon within the field and that acted upon by the same liquid outside of the field varies, according to the liquid used, from a very small amount, much less than the hundred thousandth of a volt, to several hundredths of a volt.

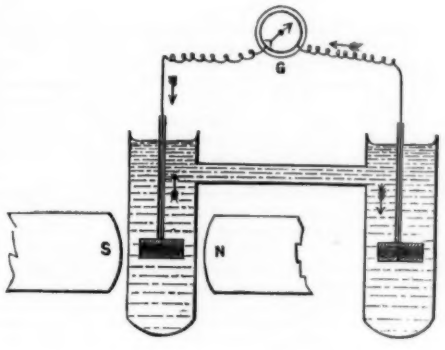
4. The E.M.F. increases, as a rule, with the activity of the solution, *i.e.*, with the rapidity of the reaction.

5. The E.M.F. is much greater when the result of the reaction is a ferric salt of iron than when a ferrous salt is formed.

6. The direction of the current depends upon the way in which the electrode within the field is exposed to the action of the liquid. When this electrode is protected, excepting in those portions of its surface which lie nearest to the induced magnetic poles within the electrode, the exposed surface becomes in its voltaic relation to iron outside of the field as *zinc* to *platinum.* The current then flows from the magnetised electrode through the solution to the electrode outside of the field.

The accompanying diagram shows one form of apparatus in which the above-mentioned conditions are fulfilled.

A cell is used consisting of two glass tubes, closed at their lower ends and connected by a horizontal tube of the same material. These tubes and the connecting arm are filled with an electrolyte capable of attacking iron. Two short bars, cut from the same piece of iron, and of the same size and shape, each attached in the middle to a copper wire, are coated with wax, excepting at their ends. The wires make electrical contact with the bars at the points of attachment, but are insulated otherwise throughout their entire length. The free ends of these wires are connected through a sensitive galvanometer. When the bars are then inserted



into the cell, one in each upright tube, a voltaic circuit is formed, which, aside from the currents due to variations in the character of the iron and liquid, or to differences of temperature in the two arms of the cell, is capable of developing no electromotive force. When, however, one of the tubes is placed between the poles of an electro-magnet, the axis of the bar being parallel to the lines of force, a permanent current is generated, the ends of the bar within the magnetic field becoming as *zinc* to the bar which is not subjected to magnetisation. As already stated, *the current then flows from the metal within the field through the solution to that outside of the field.* When the copper wires are attached to one end of the iron bars and the surface at the middle only of each bar is exposed to the liquid, the direction of the current is reversed. The bar within the field becomes as *platinum* to that outside, and *the current flows from the non-magnetised bar through the solution to the bar which lies between the poles of the magnet.*

7. Experiments upon "iron-platinum" and "iron-copper" cells within the magnetic field led to similar results. The electromotive force of such cells was increased by the action of the magnet whenever the portions of the iron electrode nearest the induced poles within the same were exposed to the action of the liquid, and was diminished whenever only the neutral portions lying midway between the induced poles in the electrode were so exposed.

8. The E.M.F. obtained under the conditions above described increases with the strength of the field, although not in exact proportion to the latter.

9. The E.M.F. depends upon the dimensions of the magnetised electrode, *i.e.*, upon the distance between the induced poles in the same. An experiment upon two bars of Norway iron, differing in length, but of the same cross section, exposed at the ends only, the bars being placed parallel to the lines of force, showed the E.M.F. between the end of the bar and an electrode of

* Abstract of a paper read at the New York meeting of the American Association for the Advancement of Science, August, 1887.

† Th. Gross: "Ueber eine neue Entstehungsweise galvanischer Ströme durch Magnetismus;" Sitzungsberichte der Wiener Academie, Bd. 92, 1885.

‡ E. L. Nichols: The chemical behaviour of iron in the magnetic field; American Journal of Science, Vol. 31, p. 272.

similar iron outside of the field to be much greater in the case of the longer bar, the effect being approximately in proportion to the square of the length of the magnetised bar.

10. It follows from the above that whenever iron is acted upon by acids or other reagents in the magnetic field, local voltaic action will occur between those portions of the iron which become magnetic poles and the intermediate neutral positions, the poles becoming as *zinc*, the neutral parts as *platinum*. To this local action we believe is to be ascribed in part, if not altogether, those peculiarities of chemical action in the magnetic field which formed the subject of the paper already cited. The power of magnetism to destroy the passivity of iron in nitric acid, to which attention was first called at that time and which we have since investigated at greater length,* is doubtless due in like manner to these local currents.

ON ELECTRIC STREET CARS; WITH SPECIAL REFERENCE TO METHODS OF GEARING.†

By A. RECKENZAUN, C.E.

SCARCELY nine months have passed since your esteemed president, Mr. T. C. Martin, presented a paper on "Electric Street Cars" to this American Institute of Electrical Engineers. I have read this excellent paper with interest, and I have learned a great deal from it, as also from the discussion which followed. Mr. Martin compiled some very important statistics regarding the number of horse cars in actual use in the United States, and he computed them to number 25,000, for the propulsion of which no less than 120,000 horses are requisite.

These figures filled me with wonderment and surprise, and when I read further on, that over 20,000 of these noble animals are rendered useless every year with overwork in street railway service, I felt it to be the duty of every engineer, electrical or mechanical, to assist with every means in his power in the emancipation of the horse from such cruel service. The percentage of loss given in the paper referred to agrees closely with our European experience. We know that the natural life of a street car horse is reduced to about four years, although it never works more than four hours a day. It seems barbarous, therefore, to employ animals for such purposes; yet until recently no economical substitute could be found. Steam, compressed air, gas and spring motors have been tried and found inefficient. Improvements may be made in one or more of these, but at the present moment the field of enterprise is entirely open to the cable and to electricity. There are over 80 miles of cable roads in operation in the United States, more than half of which have been laid down within the last five years, and there are indications that further and rapid progress will be made with this mode of traction, particularly in hilly districts, where it is impossible to apply self-propelled cars, owing to the want of cohesion between the wheels and rails when the angle of repose is approached.

On ordinary streets with gradients of not more than 5 per cent. electric traction will doubtless be more economical and far more convenient than cables, for well-known reasons. Not only is the first cost of construction far cheaper than the cable and its conduit, but the efficiency of the electric system is much greater.

It is admitted that on cable tramways some 70 or 80 per cent. of the total available power is consumed in dragging the cable itself, leaving a maximum of 30 per cent. for moving the cars, whereas with electric transmission over 50 per cent. can be utilised, as will be seen by the following figures, which I have obtained from experiments on the electric railway at Frankfort in Germany. This line is worked by the overhead conductor system. Its total length is four and one-tenth miles, double track and grooved rails. The entire circuit of the conductor is eight and one-fourth miles long, and its electrical resistance was calculated to be 1·6 ohm.

EFFICIENCY AND WORKING COSTS.

During the experiments referred to, two cars were propelled at a speed of seven and a half miles an hour; one of these cars had an electric motor, and the other was an ordinary car attached to the first, and the entire weight was ascertained to be 8·35 tons, including passengers. Electrical measurements were taken from the dynamo at the power station simultaneously with those on the car. The rails were in their usual dirty condition. When running on the level road the energy used on the cars was 3·87 horse-power, and on the generating dynamo 6·47, giving an efficiency of 59·82 per cent.; when travelling up a grade of 1 in 45, the motor gave eight horse-power and the dynamo 13·5, which again correspond to 59 per cent. of the available electric energy. These measurements do not include the losses in the dynamo and motor, but it must be remembered that only two cars were on the road, while the capacity of the plant at the central station was sufficient for 14 cars. With 12 cars running under the ordinary circumstances of traffic, the steam engines were indicated, and this showed a maximum of 164 horse-power, consuming two and three-fourth tons of coal per day of 15 hours, or two and one-half pounds per indicated horse-power per hour. Reduced to car miles, the weight of coal came to 7·5 pounds, which, at three dollars a ton, would cost one cent. per mile run.

The Frankfort Electric Railway has carried over 3,000,000 passengers since its opening in April, 1884. The working expenses in the year 1886 amounted to $24,904, including the following items:—

Salaries of directors, superintendent, engineers, electricians, conductors, drivers, firemen, and labourers ...	$13,615
Repairs of roadway, rails, cars, machinery and buildings	5,088
Fuel (coals and kindling wood)	3,955
Oil and waste	831
Lighting and heating of buildings, lighting of cars and streets	1,415
	$24,904

The rolling stock consisted of fourteen cars, all of which were used on Sundays and holidays, but only eight cars were usually running on week days. If we take an average of ten cars, then the entire expenses would amount to $6·82 per car per day, but not more than one-third of this, or $2·27, can be reckoned for the item of traction, which should only include wages of engineers, electricians, firemen, cost of coals, oil, and repairs to machinery.

There are about a dozen electric railways in successful operation in Europe, some more extensive than the one I have just described, some smaller; but this one in Frankfort is worked at a greater expense than any of the others I know of; it has been in continuous use for nearly three and a-half years, and I thought that by giving you detailed and exact figures of *one* line, I should serve your purpose better than by attempting to crowd a few generalities of all our electric tramways into the small compass of a short paper. You can take this as a safe standard of comparison with other systems of street car traction.

It will be observed, with justice, that the dynamos and motors of the Frankfort line, which was projected more than four years ago, do not yield as high an efficiency as more recent machines. This would leave us another margin. It is well to have a margin in all our estimates, for there is nothing that retards the progress of a novel enterprise more than exaggeration of facts, or statements which cannot be fully borne out in practice.

Some people are apt to base their calculations and estimates upon theoretical conditions. We should never assume perfection in the case of street railway tracks, but on the contrary we ought to adapt ourselves to the roughest of the rough in order to succeed.

TRACTIVE FORCE AND MECHANICAL RESISTANCES.

We know from experience that street rails which are exposed to dirt, grit, stones and the like, offer a resistance of at least 20 pounds per ton with the wheels in motion. Taking the loaded car at six tons, and the speed at six miles an hour, we have to exert 1·92 H.P. at the driving wheels, neglecting friction of gearing and losses in the electric motors. On narrow grooved rails, as used in England, we allow a tractive force of from 25 to 30 pounds per ton. These high resistances are readily accounted for when it is considered that the flanges of wheels frequently take a bearing on the dirt in the grooves; at the same time the wheel tires may roll on the surface of the rails, when a regular grinding action is produced. Furthermore, it occurs frequently that one wheel is running on its proper bearing surface, while the other, belonging to the same axle, has its flange touching the bottom of the groove, when by virtue of different circumferential velocities, additional friction is introduced. Sometimes the rails are a little out of guage. All these points increase the tractive force requisite with grooved rails. Here in America you have few if any such rails; consequently the facilities are superior; but your rails are not so strong as those used in England and on the continent of Europe, and the foundations are less substantial. The joints are also somewhat irregular, and these faults render the motion of a car very unsteady. A ride on some of the roads in Philadelphia reminds one of a voyage on the ocean when the sea is a little rough. Then you crowd very often 70 passengers into a car which is supposed to hold about 30. All these circumstances compel us to provide plenty of power in order that every obstacle can be overcome.

The force necessary for starting a car is, of course, much greater than the force required for maintaining a uniform speed, and experiments show that this initial effort amounts to three times and even four times the tractive force of the car in motion. In dry weather, on curves of 50 feet radius, the resistance to traction is doubled, and on those of 35 feet radius trebled; but when the rails are wet this resistance, due to curvature, is considerably reduced. With a short wheel base, or, better still, with small trucks or radiating axles, the motion on curved rails is very much easier.

GRADIENTS.

The effect of gradients is a matter of simple calculation, and it must be provided for in designing and constructing a motor. We have calculated above, that the minimum effective power for a

* On the Destruction of the Passivity of Iron by Magnetisation; Proceedings of the Kansas Academy of Sciences, 1885–86.

† Read before a special meeting of the American Institute of Electrical Engineers, September 20th, 1887.

six-ton car running at six miles an hour on the level is nearly two horse-power, exclusive of gear friction or any other waste. If we have to overcome a gradient of one per cent., for instance, the resistance due to gravity will be 22·4 pounds for each ton, or 134·4 pounds for the loaded car. Therefore we shall require about four horse-power to pull this car up a grade of 1 in 100. With a two per cent. grade we must have about three times the power used on level roads, and, roughly speaking, each per cent. of grade involves as much energy as the propulsion of a given weight over a horizontal road, if the speed is to be kept constant. On steep grades, however, it is customary to run a little slower, whereby some of the energy is saved; but for a car of the above weight, if it has to overcome grades of four per cent. it will not be safe to have less than eight horse-power available upon the driving axles. In addition to this the motor has to supply the power which is unavoidably wasted in the gearing used for transmitting motion from the armature shaft to the car axle. An ordinary street car wheel of 30-inch diameter has to revolve at least 77 times in the minute, in order to traverse a distance of seven miles an hour. Up to the present time no one has succeeded in constructing an electric motor of reasonable dimensions, weight and efficiency, to work at such a low speed. Most of the existing motors revolve at from six to twelve times the above velocity ratio, therefore it became necessary to introduce speed-reducing appliances between the motor and the driving axles.

Gearing.

The problem of devising suitable gearing for street cars carrying their own motor has been and is still one of the greatest importance, and I propose now to offer a few remarks with reference to this subject, by citing some examples which came under my own observations. The conditions to be satisfied are by no means simple, and it is somewhat difficult to arrange them in their order of merit. Most engineers endeavour to retain the recognised dimensions of street cars, because great deviations therefrom involve many inconveniences, and it is wise to adhere as much as possible to the rules which have been established by custom, convenience and general utility. The fact that most of the street cars in all parts of the world are similar in shape, indicates forcibly that a particular pattern satisfies the demand. When taking that popular pattern of car and adapting it to our electrical and mechanical apparatus, we find that the space at our disposal underneath the floor and between the axles is meagre and extremely limited. Within this small compass we have to fix the gearing which has to give the highest possible return of a given power; it has to be strong, durable, yet light in weight; noise and vibration have to be carefully avoided; the mechanism must be simple, certain in its action; protected from wet and dirt, and finally, of reasonable cost. How to combine all these virtues has been the study of every engineer who has made electrical traction his serious study.

Steel Spiral Cords.

In regard to my own observations, one of the prettiest kinds of gearing in actual use is that on one of the cars of the Berlin-Lichterfelde Electric Tramway, which was constructed six and a-half years ago by Messrs. Siemens and Halske. This car has a capacity for 24 passengers; it weighs when empty 3·2 tons and has a speed of 12 miles an hour. The electric motor is fastened under the floor in the centre of the car, having its shaft parallel to the axles. On the motor shaft is a small cast iron pulley, which has 27 V-grooves on its rim, and within these grooves work an equal number of spiral wire ropes, which transmit the motion to both axles of the four-wheeled car. The axles carry the large pulleys, one of which has 13 V-grooves on its circumference, and the other 14 grooves corresponding with those on the pulley on the motor shaft. The wheel base is 5 feet 9 inches, consequently there is only a distance of two feet ten and a half inches between the centres of the connected pulleys.

The ropes are made of a pair of steel wires wound closely upon a mandrel of about one-eighth of an inch in diameter, and when this mandrel is withdrawn there remains a stiff, yet flexible spiral, whose external diameter is scarcely $\frac{7}{32}$ of an inch. When cut to the proper length these cords are stretched over the grooves and connected at the ends by means of steel eyes and a steel link. Experiments made with this gear showed that eight spiral ropes sufficed for transmitting the power to the axles when the car was full of passengers, and as there are actually 27 cords the margin of safety was deemed more than sufficient. It is a pleasure to ride on this car; there is no noise or vibration, and I was told that the spirals last a long time if carefully adjusted; but this method of transmission is not sufficiently positive to warrant its application on steep grades. On this line there is no grade of over one per cent. rise.

Chain Gearing.

The second car on the Lichterfelde tramway, which, by the way, must be regarded as the oldest line in the world, as far as continuous successful operation is concerned, has chain gearing. The motor shaft is provided with a small toothed wheel, and one of the axles carries a large wheel with teeth to correspond to the gaps in the pitch chain links. This mode of transmission causes some noise and vibration, and this car runs slower than the other with the same amount of energy. This is accounted for by the greater friction on the surface of the teeth, as well as by the bending and unbending of the link joints; there is, besides, a constant probability of the comparatively heavy chain being thrown off tangentially by centrifugal force. But this kind of gearing furnishes an absolute or positive motion, which cannot be relied on in methods depending upon frictional adhesion alone.

Some four years ago I applied two pitch chains, four toothed wheels and countershaft for propelling a heavy storage battery car in London. The chains were of steel and substantially made; the wheels of phosphor bronze correctly shaped. I found that the chain on the fast running, first-motion, shaft rattled considerably. This chain stretched a little when the links began to ride upon the points of the teeth, and eventually broke the teeth of the small wheel on the armature shaft. Previous to that I employed some other gear, which will be mentioned shortly.

Mr. Traill, the manager of the Portrush Electric Railway in Ireland, has been more fortunate than I with chain gear, but he is not perfectly satisfied, and he is now experimenting with something else. Pitch chains are also used on the Bessbrook-Newry Electric Railway and on the Ryde Pier cars. Mr. Holroyd Smith adopted this mode of transmission on the first cars at Blackpool, in England, but he has since changed it to worm gearing, with which he is better satisfied.

Conical Discs and Chains.

About five years ago I had the idea that it might be advantageous to vary the speed of a car mechanically without interfering with the motor or even the supply circuit. I took out a patent for this in 1882, and applied it to the propulsion of a large street car. The motor was carried by a frame supported upon the axles by bearings and springs, to counteract the effects of vibration. By this arrangement the whole apparatus was rendered independent of the car body, and it could be easily detached. The speed pulleys consisted of conical discs, which, when placed face to face on a shaft, each pair formed between them a grooved pulley, and by shifting these discs on the shaft toward or from each other, the said groove could be made wider or narrower, as desired. Two pairs of discs on different shafts were connected by means of a chain, the links of which were surrounded by wedge-shaped pieces of leather. The cross section of this chain band was thus shaped in order to fit into the V-grooves offered by the cones. When the said discs were pressed closely together, then the band assumed a position near the circumference of the discs, but when the latter were separated, then the groove widened, the band changed its position and ran on some portion of the conical surfaces nearer the centre of the pulley. Thus the effective or acting diameter of the first motion pulley was varied at will by pressure, and the cones on the second motion shaft followed suit automatically, because the length of the band was constant, and the second pair of cones was pressed together by a strong spring. This arrangement looked very nice, but its efficiency was low; there was a great waste of power through friction, and we finally abandoned it. It worked silently; it was strong and took up little room. The band slipped often when the car was starting or mounting an incline.

Straps and Pulleys.

Mr. Volk, of Brighton, England, employs leather link belts with great success, for transmitting the power of the motor to the car axle. This railway has been in operation since August, 1883. Mr. Volk tried first, single leather belts, but they broke every day or two; then he used double belts with little better results, and some three years ago he adopted the leather link belt, which has given entire satisfaction. I have seen one of the latter which has driven a car over 50,000 miles, and it was not worn out yet. These belts stretch when first put on; the bearings of the countershaft are therefore made adjustable by means of a slide whereby the slack may readily be taken up. When starting the car the belts slip a little, but this is not considered a disadvantage. There are no curves on the Brighton line, and I often wondered whether this method of gearing would satisfy the terrible pull on the very sharp curves which occur on some street railways.

Mr. Van Depoele has given a high testimony in favour of link belts of a special construction after using them for a considerable time, and running them at a great velocity. Like Mr. Volk, he attaches the motor to the car body in order to give it the benefit of the existing flexibility of the car springs. Mr. Van Depoele's link belts, I understand, are made of steel, with special bearing surfaces; they have been used on a line of his construction at Windsor, in Canada; at Scranton, Pa., he employs spur gearing.

Spur Gearing.

There exists a variety of opinions on the subject of toothed wheels in connection with electric motors, and each opinion seems based on actual experience. I have seen spur gearing used on electric cars in Europe and in this country, and I give you freely all I know about it. The first I saw was on the Moedling line, near Vienna, in Austria. The noise created there was not very great, but there was occasionally some trouble due to the untimely deterioration of the teeth. This was especially remarked by the manager of the Frankfort Electric Railway in Germany, which is constructed on precisely the same principles, with the difference that the former runs through a country district where there is much less traffic, and the rails are laid on the tops of transverse sleepers like a steam railroad; there is less dust and mud to contend with. Between Frankfort and Offenbach, on the other hand, the rails are laid through populated streets, whereby all the disadvantages of city traffic are brought into play. The gearing of the cars on this line is very noisy and it wears out quickly. The train of wheels consists of a pinion on the motor shaft having 17 teeth, which gears into a spur wheel of 56 teeth

keyed upon a countershaft. On this countershaft is a pinion of 26 teeth, and this drives a spur wheel of 52 teeth, fastened to the car axle. The velocity ratio, therefore, is as 1 to 6·6 between the motor spindle and the driven axle. The armature makes about 550 revolutions when the car travels at the rate of seven and a half miles an hour. The pinions are made of hard gun-metal, and they wear out in about a month. I have seen a number of rejected pinions, the teeth of which were ground into the shape of a fine wedge. The spur wheels are of cast steel, and they last about ten months when in continuous service. I was surprised to see these; and what with the noise, the excessive weight, and other drawbacks, it made me more than ever prejudiced against such a mode of mechanical transmission on street cars. My views on this point have, however, been somewhat modified since I have been in this country. I had the privilege of being invited to assist Mr. W. Wharton, Jun., of Philadelphia, in fitting up an electric street car. There we used a set of spur gearing which was supplied by the Sprague Company. In this case the motor shaft, which runs at from 500 to 600 revolutions a minute, carries two steel pinions, one at each end of the shaft, and these pinions gear direct into two cast-iron spur wheels upon the driving axle, without any intermediate wheels. The motor is partly suspended on the axle and partly on the body of the car. We have run several hundred miles with this car under all conditions of load, gradients and weather, on some of the roughest tracks in Philadelphia, but up to this moment not a single hitch has occurred. The gearing is practically noiseless, it is efficient and strong, and I see comparatively little indication of wear. The teeth are beautifully shaped, therefore somewhat expensive, but if they last long enough, and if they do not rattle when partially worn, this expense can be ignored. This car contains, besides its usual weight, about 3,200 pounds of storage batteries; it has to mount grades of 5 per cent., and run on curves of 35 and even 25 feet radius, which means very hard work.

FRICTION GEAR.

There is something quite fascinating in friction gear; it offers the advantages of simplicity, noiselessness, and theoretically a high efficiency; but as regards certainty of action and durability, it occupies a low position in the scale of appliances for the transmission of power. The late Prof. Fleeming Jenkin devised an apparatus a few years ago which he called "nest gearing," and of which great things were expected, and indeed it was regarded as the most perfect frictional gear ever invented.

Prof. Jenkin arranged several rollers within a ring; these rollers were in contact with a central friction wheel which was attached to the motor, and the outer ring was connected to the driven object. It is well known that in a pair of friction wheels when running together the contact surfaces are exceedingly small, the pressure must be great and consequently there is a rapid destruction of the said contact surfaces. Now, by placing a number of rollers within a ring, not only are the contacts multiplied, but there is a perfectly balanced pressure upon all the working parts. This kind of gearing, made of the best materials and of the finest workmanship, has been applied to the telpher line at Glynde. Its efficiency was tested and found to be somewhere near 95 per cent. In the case of telpher lines the motor and its attachments are well out of reach, suspended on tall posts, therefore dust and dirt can be absolutely excluded. The energy transmitted between the electric motor and the driving wheels averaged only 1·5 horse-power, and yet with all these advantages and the great care exercised in its construction and use, this gearing refused to act after a comparatively short space of time. The experiments were watched with intense interest by all who made mechanical science their profession, and especially by those who were seeking effective means of transmitting motion from electric motors. After a number of exhaustive tests, apparent improvements and modifications, the inventors of this nest gearing pronounced it a failure, and finally resorted to chains and cog wheels. This fact, established after prolonged and most persistent efforts on the part of a number of the smartest mechanicians, should be a warning to all the advocates of friction gear for street car propulsion.

WORM GEARING.

Dissatisfied with the results of my early experiments I resolved to give worm gearing a trial. I collected all the data I could find in text books and from other people's experience. All the different authorities agreed on one point, and that was the efficiency, or rather the want of efficiency in worm gearing. According to various statements the *loss* with this mode of transmission was put down at from 33 to 75 per cent. This seemed to me a terrible waste of power; I was then, as now, engaged in the problem of utilising storage batteries for street car propulsion. Storage batteries were at that time in disrepute generally, and as for putting these cumbersome things upon a car, the very idea of it was ridiculed by conservative-minded men. Certain would-be experts published their views on this subject, and they endeavoured to prove mathematically that the battery could scarcely hold sufficient energy to propel its own weight, and that more than 50 per cent. of the power given by the charging dynamos was lost in the process of transformation. If they had known at the time that I proposed to introduce another energy-consuming apparatus in the form of worm gearing they would have declared me a lunatic. There were, however, quite a number of extenuating circumstances which encouraged me to pursue this question. I knew, from experience, that the storage battery, if properly constructed and used, could return more than 70 per cent. of the energy expended upon it. I knew also that a certain type of cell could propel several times its own weight at a speed greater than that of a horse car.

With regard to worm gearing I found that this method of transmission was used for hoists and for actuating machine tools, and that in some cases it has been working for 20 years without requiring any expensive repairs. During all my researches I failed to discover any reliable data on the construction and use of a worm which had such a steep thread that the worm-wheel could cause it to revolve. I did not come across any publication with figures to show the efficiency of gearing where the worm shaft revolved at a very high velocity while transmitting considerable power. Just at that time the valuable researches of Profs. Thurston and Kimball and Mr. Beauchamp Tower, on the subject of friction and lubrication, were published, and these revealed the fact that all the long-established laws on friction were entirely wrong. The experiments of these scientists proves conclusively that the coefficient of friction varied with the velocity, and that it decreased up to certain limits, with an increase of speed between lubricated surfaces.

Furthermore, it has been demonstrated that the coefficient of friction between lubricated bearings is not ·1 or ·2, as so frequently stated in text books, but ·003 and less, and that even with moderately bad lubrication it amounted to only ·01. All these and other considerations encouraged me in the belief that there is a fruitful field for further investigation, and I designed a set of worm gear of the following dimensions: Steel worm, turned and polished, 6 inches in diameter, 6 inches long, treble thread of 2 inches pitch; worm wheel of phosphor bronze, trimmed teeth, $15\frac{9}{32}$ inches diameter, $3\frac{1}{2}$ inch face, 24 teeth. Ratio of gear, 8 to 1. The worm was fitted to the spindle of an electric motor, and the worm wheel attached to the axle of a street car, which was supported on a frame with bearings to keep the wheels off the ground. When running empty, with the worm out of gear, the motor took 6 ampères of current, and when put in gear, but without any other load, 7·75 ampères were used to drive the apparatus at the same speed. Prony brakes were then applied to both the motor shaft and the car axle, and the power was measured on each at a given E.M.F. current and speed. The efficiency of the gearing was calculated by dividing the horse-power given off on the axle by that measured on the worm shaft, and we found that the useful effect increased with the speed, viz., at 300 revolutions of the worm it gave 80 per cent.; at 530 revolutions, 81·1 per cent.; at 676 revolutions, 85·1 per cent., and finally at 770 revolutions, 87 per cent. These results were then compared with the electrical energy supplied to the motor in each experiment and they were found to correspond very closely, after the usual electrical losses in the motor itself were deducted. The mechanical horse-power was thus checked by the electrical horse-power, and at last I applied the well-known formula for the efficiency of worm gear, which is given in every book on mechanical engineering.

$$\xi = \frac{\cot\theta}{\cot(\theta - \phi)} = \frac{1 - \mu\frac{p}{2\pi r}}{1 + \mu\frac{2\pi r}{p}}$$

Where θ is the angle of the worm thread,
μ the coefficient of friction,
r the radius of the worm, and
ϕ the angle of repose between metal and metal,
ξ gives the efficiency of the pair.

If the coefficient of friction is taken at ·015, then the efficiency must be 87·5 per cent.

By means of the above tests and the formula we can find the coefficient of friction for the various speeds.

When this apparatus was attached to the car, I found that it required less current to propel it than it did previously with the chain gear, therefore I adopted worm gear ever since. Mr. Holroyd Smith tried it recently on his cars, as already stated, and he told the meeting of the Society of Arts, in April last, that he "found it the most effective mode of transmitting the power from the motor spindle to the axle, taking all points into consideration."

With these remarks closes a short and incomplete chapter on gearing. There are other kinds of gearing which I have not touched upon. I cannot do better than to leave the subject in the able hands of members present, who, I hope, will supplement, criticise and amend the observations herein set forth, and thereby add to the general knowledge of one of the most important topics of the day. We are continually advancing; every hour marks a step forward in the direction of success. The grand general principles of the electrical transmission of energy are now well understood, but there are yet many other ways of adding to the sum of human knowledge, as for example, in following up the details of construction, every one of which will add in some measure to the final triumph. Even by relating our mistakes and failures we serve a good purpose. "There are," said Professor Silvanus Thompson, "half-forgotten observations, unconnected, unexplained, and often exceptional in character, every one of which has a significance of its own—residual phenomena, every one of which is, to the scientific man, of a value beyond price. He who investigates them patiently may find the clue to their meaning and reap a rich reward from them. They are the finger posts in the high road of discovery."

Gift to the Pope.—Among the many strange jubilee gifts to be offered to his Holiness the Pope is a contrivance by a French engineer, named Arragon, for ringing large church bells by electricity.

SCIENTIFIC LECTURE AT THE NEWCASTLE EXHIBITION.

ON Monday last Prof. Garnett lectured in the Theatre of the Newcastle Exhibition on various electrical appliances. In the early part of the lecture attention was directed to the different means of developing electric currents, and it was shown that the current produced by an induction machine of the Wimshurst type, and capable of producing long sparks in air would deflect the spot of light from the galvanometer through a distance of only two or three inches on the screen, while the current obtained by twisting together a piece of copper wire and a piece of iron wire, and heating the junction, sent the spot of light a long way off the screen and across the wall of the theatre. Two platinum wires immersed in dilute sulphuric acid in the oxy-hydrogen microscope served to show the decomposition of water and the production of large bubbles of gas when the current from a hand Gramme machine was sent through the liquid. With two lead wires and a small current it appeared that the oxygen was absorbed and only the hydrogen escaped; when the lead wires were coated with litharge both gases were absorbed. The polarised wire, of course, maintained a current through the galvanometer when connected with it, and in this way the action of storage cells was illustrated. Towards the close of the lecture an electrical welder, constructed by Mr. Manville of the United Electrical Engineering Company, was shown in action, the current being supplied from an alternating Gramme machine a quarter of a mile away. The welder was manipulated by Mr. Stewart, of Messrs. Woodhouse & Rawson. The transformer of Messrs. Paris & Scott, of Norwich, was afterwards exhibited in action, and was employed to light a number of lamps. It proved to be self-regulating to a very satisfactory extent, and half the lamps could be suddenly switched off without sensibly affecting the remainder. The engine room being a quarter of a mile from the theatre, and there being no telegraph between, some delay took place in getting the leads transferred from the alternating machine to the continuous current machine. After exhibiting the welder, and during the interval, Mr. Stewart suggested trying the effect of the alternating current on Messrs. Paris & Scott's transformer. Of course the armature remained stationary, but the apparatus answered admirably as an alternating current transformer, and the electromotive force in the secondary coil appeared, from the glow of the lamps, to bear the same relation to that in the primary when alternating currents were employed and the armature at rest, as when continuous currents were used and the armature made to rotate. It will be remembered that Messrs. Paris & Scott's transformer is simply a motor and dynamo of their well-known type combined, so that the two sets of coils are wound on the same armature. The high tension current drives the armature as a motor and excites the field, while the secondary current is induced in the low resistance coils of the armature and supplies the lamps.

Among the other apparatus exhibited at the lecture may be mentioned small lamps for surgical purposes surrounded with a water jacket, in which water circulates to prevent undue rise of temperature, and a model brougham the property of Messrs. Atkinson and Philipson, which was lighted by incandescent lamps supplied with currents from Schanschieff's sulphate of mercury battery.

ELECTRIC LIGHTING IN MILLS.

ON the evening of the 10th inst. Prof. Ewing gave the first of a course of ten popular lectures on electric lighting in the Engineering Class-room of University College, Dundee, the subject of the introductory lecture being "The Present Position and Prospects of the Electric Lighting Industry." The lecturer spoke of the progress in electric lighting which the last five years had brought about, under the several heads of production of electricity, storage, distribution, and lamps. The apparatus was now vastly more efficient and very much cheaper. Dr. Fleming had lately shown that the first cost of a large dynamo was then about £2 per lamp, now it was only 7s. Lamps were now more durable. Storage batteries were trustworthy and permanent. By transformers it had become possible to convey electric energy in the form of a current of small quantity at great pressure, thereby requiring only small conductors, and then convert that into currents of large quantity and low pressure suitable for ordinary domestic use. By this means the problem of economically distributing electricity for incandescent lighting from a central station was in a fair way to be solved, and in the last year Mr. Westinghouse had put up 27 such stations.

Apart from the question of general distribution from central stations, the electric light was now an assured success as the illuminant of large open spaces, of ships, of exhibitions, of theatres, of the country mansions of the rich, and of mills and factories. This last application was the one of greatest interest to a Dundee audience. The question that determined the use of the electric light there was almost wholly a question of cost. Was it or was it not cheaper than gas? To that question it was now possible to give a definite answer. Supposing, as was often the case in Dundee mills, the power required could be taken from the mill engine, then wherever night work was to be done electric lighting by incandescent lamps was unquestionably cheaper than gas. If there was only day work—that is, if light was required only for a few hours in the early morning and the late afternoon of the winter months—then gas and electricity ran almost neck and neck as regards cost; but if light was wanted for anything like a thousand hours in the year then electricity was distinctly cheaper, even allowing in the most liberal way for interest and depreciation on the permanent plant, as well as for the cost of lamp renewals, coal, oil, &c. More than two years ago he pointed this out in a lecture in Dundee as the result of a calculation, and shortly after he had the opportunity of making practical proof in mills in the Dundee district where he had been consulted professionally regarding the electric light. In one of these factories the calender was lighted by electricity, and was used occasionally for night work. After two years' use the manager had given him figures for the actual cost. For 1,200 hours' work during one year the whole cost of lighting by electricity, including interest and depreciation, was under £50. The same area had formerly been lighted by gas, and the gas bill for the same number of hours' work had been £82. If the plant had been of the most modern kind the difference would have been still greater in favour of electricity. In another case, in the underground warehouse of a Dundee mill, where they had formerly made shift to work with the dimmest light for fear of fire, the electric light had been introduced under his supervision, and the results had been very interesting. He recommended that as a brilliant light was not wanted the lamps should be worked, for the sake of economy, at a low degree of incandescence. This had been done, and some of the lamps, burning every working day for 10 hours, had lasted for more than 7,000 hours. Their average life had been 5,500 hours. In conclusion, the lecturer said there were many signs that the electric light industry, after a long time of great depression—during which, however, the engineers had not been idle—was about to enter on a period of rapid growth. Any one who made it his business to watch the progress of invention in this department must be filled, as he was, with a growing faith in the brilliant future of the electric light.

REVIEWS.

Dictionnaire d'Electricité et de Magnétisme, étymologique, historique, theorique, technique, avec la synonymie Française, Allemande, et Anglaise. Par ERNEST JACQUEZ, Chargé du Service de la Bibliothéque Scientifique et Administrative de la Direction Generale des Postes et des Télégraphes, Officier d'Académie. Nouvelle Edition, entièrement refonder et considerablement augmentée. Paris: Libraire C. Klincksieck, 11, Rue de Lille.

As compared with the first edition (issued in 1883), the new edition of this work shows a considerable improvement; more than 400 new expressions have been added, and a more complete connection between the various parts has been established. A short biographical notice of the principal ancient and modern electricians has been added. Frequent references are made to the sources from which the information given is derived. Altogether considerable pains have been taken to make the book as complete as possible, and the result is very creditable to the author.

A Handbook of Electrical Testing. By H. R. KEMPE. Fourth Edition. London: E. and F. N. Spon, 125, Strand.

The fourth edition of this well-known work (which has been adopted by the Postal Telegraph Department) shows an addition of over 60 pages to the last issue. The principal new matter relates to the chapters on Galvanometers, the Wheatstone Bridge, Fault Testing, Temperature Corrections, and the Measurement of High Resistances, though in almost every chapter some additions and corrections have been made.

The Liepmann Battery.—We have for some time past heard it privately stated that the Liepmann battery was capable of giving excellent results. We have this week seen the data of some experiments taken during a 30 hours trial, and these appear to show that the reports we had previously heard were not too highly coloured. However, we hope shortly to be in a position to give figures which shall speak for themselves.

NOTES.

The Electric Light at Waterford.—A "Citizen" of Waterford writing to *Invention* with reference to a paragraph appearing in that journal, headed "Gas and Oil: the Oil Lamp Triumphant," says: "I would beg leave to explain this matter in its proper light. The oil lamps do not deserve the praise they receive, neither are they a success. The City of Waterford is not lighted by them, but by the electric light, which lights all the main streets. The oil lamps only light the smaller and outskirting streets, and they are not as well lighted as they were by the gas lamps. The electric light is supplied from a plant fitted up by Messrs. Laing, Wharton, and Down, on the Thomson-Houston system, which deserves the credit of superseding the gas, which it does very creditably, giving a very steady and beautiful light."

The Electric Light in the Royal Navy. — The Admiralty have issued a fleet circular, emphasising the importance of target practice being carried out after dark with quick-firing and machine guns. Where vessels possess the electric light it is to be used at the discretion of the commander. Beyond 500 yards the search lights may be employed for the purpose of discovering the targets, but at less than that distance the target is supposed to be discoverable without such aid. Where electrically illuminated sights are not used, the best way of lighting the sights is left to the discretion of the commander.

Perth and the Electric Light.—A special meeting of the Perth Police Commissioners was held in committee last week for the purpose of considering whether a report should be obtained from an electrician as to the advisability of introducing the electric light for the lighting of the Perth streets. After a long discussion it was agreed to ask a joint-report from Prof. Ewing, University College, Dundee, and Mr. Duncan Forbes, engineer to Messrs. Pullar & Sons, Perth, as to their opinion on the matter, and what, if anything, they would recommend.

Electric Lighting in Brussels.—The Société Industrielle d'Electricite was successful in the competition for the lighting of the military hospital, although its tender was £240 above the lowest, because it offered to give a guarantee to hold customers free from the results of an action for infringement which might be raised by the Edison Company at any future time. Owing to the recent decision in favour of the Edison patents abroad, it is probable, says *Industries*, that the Edison Company will bring actions for infringement against rivals makers in Belgium. The Société Industrielle has also received an order for a 100 lamp installation for a spinning mill at Verviers, and another installation in a brewery at Malines. The first trial of the electric installation at the emporium of Messrs. Hirsch & Co., in Brussels, was highly successful. As already reported, this installation consists of 300 incandescent and 34 arc lamps.

Electric Lighting of Trains.—At the International Railway Congress at Milan, on the report of M. Dery, of the Belgian State Railway, Section 2 came to the conclusion that for the lighting of trains enriched gas was preferable to naphthaline, and that the difficulties in the way of electrically lighting trains were still very great, so that this portion of the subject had better stand over to the next congress.

Electric Lighting at Glasgow.—At a meeting of the Glasgow Bazaar Committee on October 4th, there was submitted a letter from Mr. Foulis with reference to the lighting of the bazaar and the City Hall, and also a memorandum from the superintendent of the bazaar with reference to certain lamps which had been recently tried. The committee having considered these, along with the reports by Mr. Bryson, were of opinion that electric lighting should be adopted for these buildings. They recommended that Mr. Bryson should be asked to prepare a specification, and that the committee should be authorised, on that being done, to get tenders for supplying the necessary apparatus, &c. Mr. Simons complained that the statement was not business-like. Nothing was put down for plant or depreciation. It was essential when making a comparison to take those things into consideration. The comparative cost of gas lighting was stated, but it was altogether wrong, because Mr. Bryson put down gas as costing 3s. 6d. per 1,000 cubic feet, whereas it only cost 2s. 10d. at the present moment. In dealing with these matters it was necessary that the committee should be perfectly accurate, and not submit statements which could not be borne out. The minutes were approved.

Ship Electric Lighting.—The new Spanish warship *Reins Regenta*, which sailed from the Clyde last week, was fitted with the electric light and all modern improvements. She is said to be the fastest warship afloat. The new steam yacht *Thetis*, built to the order of Mr. John Donaldson, Tower House, Chiswick, has been fitted up by Messrs. Muir, Mavor, and Colson, Glasgow, for electric lighting. The new P. and O. steamer *Britannia* has also been fitted up with the electric light.

Folkestone Electric Lighting.—At the meeting of the Folkestone Town Council on Tuesday, a long discussion took place again with reference to the lighting of the Lees by means of the electric light, but the matter ended as it has done before—it was allowed to drop. There is a strong feeling on the part of many of the inhabitants of Folkestone that the Lees would be greatly improved by the use of arc lights down the promenade, and steps have, it is understood, been already taken by an electric light company in endeavouring to bring about this particular method of lighting. The same company has also been attempting to introduce an electric lighting scheme at Dover, but at present no public movement has been made. It is understood, however, that the new pier at Folkestone will be lighted by the electric light, and the same mode of lighting will be used if the proposed new pier is constructed at Dover.

Telephonic Communication in Case of Fire.—As a consequence of the recent destructive fire at Gosport, the question of providing telephonic communication between the police-station and the waterworks, which had been shelved by the committee to which it was referred, again occupied the attention of the Alverstoke Local Board last Thursday. The chairman (Colonel Mumby) stated, in answer to a question, that the Roads and Works Committee were informed that a telephonic exchange was about to be started in Gosport, and they thought that they had better wait to see if that project developed, as a special wire would be rather expensive. Several members expressed the opinion that it would be better to consider the subject from a public point of view, and eventually it was resolved that the matter should be considered by the committee at their next meeting, so that they might prepare a report with reference to the cost of the telephone, &c.

Portsmouth Telephone Exchange.—At the suggestion of the Mayor (Sir William King) the Western Counties and South Wales Telephone Company has decided to open a call-room at Southsea, in connection with its Portsmouth exchange. The fee for using the room is to be twopence, a conversation of three minutes' duration being permitted for this small sum. At present there are 120 members on the exchange, and should the Southsea call-room, which will be opened by November 1st, prove a success, others will be established in various parts of the borough.

Telephone Extension in Mid-Lothian.—An extension of the telephone system is about to take place in Mid-Lothian, says the *Scotsman*. It is about five and a half years since the National Telephone Company first applied to the Edinburgh County Road Trustees for permission to extend the wires from Edinburgh to Portobello. Generally speaking, the proprietors of houses and lands along the proposed route were found quite willing to allow the system to pass over their properties; but between Leith and Portobello, Edinburgh and Portobello, Edinburgh and Liberton, and Edinburgh and Dalkeith there were certain proprietors whose objections it had been found quite impossible to overcome. The Post Office authorities refused to allow the company to put the wires along the railways, and there remained only the public roads as a possible route for the system. About three years ago a number of the county authorities in Scotland appointed delegates to meet and discuss the question of telephonic wayleaves. Some eight or nine counties were represented, and the delegates drew up a series of conditions which they agreed to adopt within their own counties. Amongst others, Mid-Lothian agreed to these terms. In all the other counties the conditions were accepted and applied; but when the application to erect the wires in Mid-Lothian was renewed, Mr. Macfie, of Dreghorn, proposed that the conditions adopted by Mid-Lothian in conjunction with the other counties should be supplemented in Mid-Lothian by stipulations: (1) that the company in return for wayleave should consent to limit its dividend in perpetuity to 10 per cent.; and (2) that it should not be permitted to connect the chief places in the county alone, but that on the requisition of the trustees the company should be compelled to open offices in any village indicated by the trustees, and to give connection from that village to Edinburgh and to the general system. It is understood that the company could not see its way to agree to either of these conditions. It considered that as it held territory in the richest part of England, in the principal part of Ireland, and in nearly the whole of Scotland, and that in none of those fields of operations were such stipulations even suggested, it would have been absurd to have agreed to them in such a small portion of Great Britain as Mid-Lothian. Besides, the erection of telephone poles and wires is very expensive, and the company considered that it would be a hardship if it was to be called upon at any moment to extend the system from Edinburgh to some remote corner of the county—perhaps 30 or 35 miles away—without a guarantee of traffic. The company offered to extend its wires to any portion of the county, provided a guarantee of a certain amount of traffic was forthcoming. For several years the Road Trustees refused to give way on the question of extension; but recently the Road Board agreed to allow the company to connect Portobello, Musselburgh, Dalkeith, and Lasswade with Edinburgh. Public call offices will be opened in these places; and the company has agreed to open call offices in two other places to be named by the trustees themselves. In deference to a wish expressed by one of the trustees from the western portion of the county, the company further agreed to open a call-office at Mid-Calder. At the same time, the company undertook to extend the system to Penicuik, Roslin, and Gorebridge, if sufficient support were received in these villages.

The Telephone at Shrewsbury. — The Western Counties and South Wales Telephone Company has opened an exchange at Shrewsbury, commencing with 25 subscribers. Additions are to be made to the list as soon as the connections can be made.

Humming of Telephone Wires.—In reference to the suggestion of Mr. John Shakespear for preventing the humming of out-of-door telephone wires, Mr. Rudolph Howard Krause writes to the *Times* from Trieste:—"It may be of interest to some of your readers to hear that this remedy has been largely used by me in all the Austrian exchanges belonging to the Telephone Company of Austria, Limited, and has been in use since 1883, that it certainly has some little effect, but certainly does not do away with the noise, which is quite as much of a nuisance to the telephone companies as it is to householders, who frequently refuse wayleaves for no other reason but dread of the noise."

Formosa Cable.—The Silvertown Company informs us that news has been received in London that Messrs. Jardine, Matheson & Co. have completed their contract with the Chinese Government for the manufacture and laying of two submarine cables, the first joining Amoy with Tamsui, Formosa, and the second connecting Amping or Tai-wan-fu on this island with the Pescadores group, which lies in the channel between Formosa and the mainland of China. The cable was manufactured for Messrs. Jardine, Matheson & Co. by the Silvertown Company, and has been laid by the cable and despatch vessel *Fee Cheu*, of the Chinese Imperial Navy, under the superintendence of Mr. Joseph Rippon, who was assisted by Captain Lugar and Mr. H. P. Daley, formerly of the Silvertown Company's staff, and now in the service of the Imperial Chinese Government.

The Great Northern and the Eastern Telegraph Companies announce that the Island of Formosa has been connected with the telegraphic system of China by means of a cable *viâ* Foochow. Stations have been opened at Tamsui, Keelung, and Taipehfoo.

The Cables between France and England.—The *Bulletin des Societés d'Electricite* says:—"We learn that the French Government is on the point of granting to the Submarine Telegraph Company the renewal for 15 years of its monopoly, which has been refused to it in England. We hope that this news is premature, and that the Government will not take a decision so injurious to the interests of telegraphy without obtaining all desirable information, and especially without asking the opinion of the Chambers of Commerce."

Commercial Cable Company.—We understand that M. de Castro, Mr. Mackay's secretary, has been appointed a director of the Mackay-Bennet Cable Company, replacing Count Dillon, who returns to his old company—the Pouyer-Quertier. With this change the arrangement which existed between these two companies for mutual assistance in case of the breaking down of either company's cables, ceases. The French company is consequently completely isolated, being now unable to send its messages by either the Commercial Company's or the associated company's cables should a breakdown in its system occur.

Electric Traction at Brussels. — It is feared that with the commencement of the winter, electric traction will undergo a compulsory interruption. Only four cars have been in use, but the accidents have been numerous enough to necessitate, in no distant future, important modifications in the system employed. The evil seems to spring from the circumstance that the motor is not well adapted to work with the accumulators. M. L. Moreau's so-called "cut circuit brake" will shortly be tried experimentally on the Brussels electric tram lines. The ordinary brake requires too many operations, which occasion a loss of time, and if mismanaged may occasion accidents. The new "cut circuit brake" requires only one movement and is much simpler in principle.

University Extension Lectures.—In connection with the London Society for the Extension of University Teaching, short courses of three weekly lectures are to be given by Mr. W. Lant-Carpenter, B.A., on "Electricity in the Service of Man," at Essex Hall, Essex Street, Strand, and at Shoreditch Town Hall. The first lecture in the Strand will be delivered on Wednesday, October 26th, and those at Shoreditch will take place on Mondays, November 21st, November 28th, and December 5th.

Royal Jubilee Exhibition, Manchester.—The electric lighting at this exhibition continues to be carried on with the most satisfactory results, no hitch of any kind having occurred. The exhibition appears to attract the attention of the public more than ever, and the attendance is very great. At 2 p.m. on Wednesday last the total number had reached 4,000,016 since the opening of the exhibition.

Personal.—We are glad to announce that Mr. W. A. Bryson, the electrician to the Royal Jubilee Exhibition, Manchester, has been appointed to a similar post at the forthcoming exhibition at Glasgow.

The Hon. R. C. Parsons, a well-known member of the Societies of Civil, Mechanical, and Telegraph Engineers, who for some years past was an active partner in the firm of Messrs. Kitson & Co., of Leeds, has resigned his connection with that firm, and is about to enter into partnership with Mr. J. F. La Trobe-Bateman, of 18, Abingdon Street, Westminster.

Obituary.—The *Daily News* Berlin correspondent announces the sudden death of Prof. Gustave Robert Kirchhoff, the famous natural philosopher and discoverer of spectrum analysis. He was born in 1824 at Konigsberg, where he held the post of professor from 1847 to 1850. From there he went in the same capacity to Breslau, where he made the personal acquaintance of Bunsen, whom he followed to Heidelberg in 1854, and there they made together the above-mentioned discovery, which is certainly one of the most important of our century. In 1875 he was called to the University of Berlin.

Heriot-Watt College.—The calendar of the Edinburgh Heriot-Watt College for the session 1887-88 is just about to be issued. The great improvements and additions both in the building and in the subjects to be taught therein, as provided by the Educational Endowments Commission, are now being carried into effect. The new building will contain lecture rooms, class rooms, laboratories, and workshops for the carrying on of technical and general education. The west wing of the building is almost completed, and in the meantime arrangements have been made for the temporary accommodation of the classes. The following are the classes, all under their own lecturers and teachers, which are instituted for the first time this session :—Sound, light, and heat (advanced) ; electricity and magnetism (advanced) ; telegraphy ; electric lighting ; chemistry (general course) ; applied mechanics (advanced) ; graphical calculation ; civil engineering ; principles of mining ; mine surveying ; carpentry and joinery ; masonry and brickwork ; plumbers' work ; carriage building ; physiography ; hygiene ; shorthand (reporting) ; industrial and commercial geography, and practice of commerce.

Electrifying an Audience.—A curious case is on trial in a Chicago court. Last June, at an entertainment given in the Lyceum Theatre, electric wires were attached to the chairs in the auditorium, and during the evening the audience was treated to a more or less gentle shock from the batteries. Alpheus H. Pike received so large a portion of the current that he was laid up for a month, and he now brings suit against the management for $10,000 damages. The sympathies of the public, says the *New York World*, will be with Mr. Pike in his effort to obtain justice. Dramatic performances at present are for the most part sufficiently shocking without the aid of electric wires. If the actors in a play are not able to electrify an audience it is almost cowardly to call in the assistance of a concealed dynamo. The only excuse which could in any way serve to justify the attachment of an electric wire to a theatre chair would lie in the fact that the seat was occupied by a woman wearing a high bonnet.

An Electric Target.—Some very interesting trials are reported from the arsenal at Washington of the new Ullman electric-annunciator target. It is a time and money-saving device for rifle practice. The target can be made for rifles of any calibre and range, and the value and location of each shot striking it is accurately registered on the annunciator, which is located at the firing-stand and connected by seven wires with the target. Its face conforming in every respect to regulation targets, this target is made of a solid metal plate, or of solid rings, or with the latter divided into segments. Electrical contacts are made by the motion communicated to pendulums through pins by the force of the bullet in striking.

Catalogue.—Messrs. P. Jolin & Co., of Narrow Wine Street, Bristol, have just issued a very comprehensive illustrated descriptive catalogue of electrical, chemical, and physical apparatus, containing 128 pages. With this catalogue is combined a useful set of hints and instructions to teachers, pupils, bell-fitters, and all interested in constructing or using electrical apparatus, special instructions being given as to insulating, winding, jointing, &c., with a list of insulating compounds, formulæ for arranging batteries, calculating lengths of wire on bobbins, a list of legal and other units, standards in daily use, and comparison tables of relative cost of gas and electric light, &c. In Appendix B is a full table giving in alphabetical order all the batteries in use, with their construction, solutions, &c., clearly set forth. Many of the instruments included in this list are quite new, and are specialities of this firm ; amongst these are the "Maxwell-Jolin" dynamo galvanometer (for which a separate instruction book is also published), and the Jolin pocket galvanometer. Both of these instruments we have noticed previously ; but they have since undergone considerable improvement, which has greatly enhanced their value.

Occupation of Massowah.—We learn that the ss. *International*, belonging to the Silvertown Company, and the Telegraph Construction and Maintenance Company's ship the ss. *Kangaroo*, have been chartered by the Italian Government for condensing water at Massowah. These ships are fitted, except as to a few minor points, in the manner described in this journal on June 20th, 1885, which issue contains a very complete account of the arrangements on board the *International*.

Fire Alarm Exhibition.—An international exhibition will be held in the Champs-Elysées, Paris, from the 25th November to the 31st December, proximo, in which all systems and inventions relating to the giving the alarm and warning of fire, methods of arresting its spread, and of overcoming its dangers, will be exhibited. The exhibition will be divided into three sections sub-divided into groups, the first of which will comprise the instruments, apparatus, and systems adapted for electric lighting.

The Montgomery Electric Railway.—Montgomery, Ala., has 15 miles of electric street railway already operating within the city limits. There is no other town or city in the world which has such a system of local transportation. On this plant the city has expended $175,000 of its own money. Thirty months ago, Montgomery was without a foot of street railway. To-day there are four lines, all running from the Union depôt to the central square, and from there radiating in four directions to all quarters of the city, two of the lines extending out to Highland Park. The cars were at first propelled by mules, in the good old-fashioned way, but to-day there is not a street car mule to be found in Montgomery, every car on the 15 miles of track being propelled by an electric motor, supplied by an overhead wire from a central station. This electric system works with perfect success. The surplus from the great dynamo is carried out to Highland Park and there used to brilliantly illumine the park and the residential portion of that suburb.

The "Unemployed."—Mr. J. Money-Kent, an electrical engineer, rendered effective service to the police in Trafalgar Square on Tuesday. The "out-of-work" brigade, composed for the greater part of those who have no desire to be "in work," were pursuing their delectable proceedings, a mixture of extravagant oratory and unadulterated rowdyism, when Mr. Money-Kent, seeing a man deliberately go up to a constable and kick him savagely, ran up, struck the man in the face, then seized him round the neck and held him until constables took him into custody. Mr. Kent was attacked by the mob for making the capture, but he bravely stuck to his man.

An Electric Lighting Combination.—It is announced that an agreement has been made between the officials of the Westinghouse Electric Company and the Thomson-Houston Electric Company. The terms, as far as made public, are as follows:—The Thomson-Houston Company recognises the validity of the Gaulard-Gibbs patent, owned by the Westinghouse Electric Company, and has taken a perpetual license under it for the New England States. Hereafter the Thomson-Houston Company is to enjoy the right to manufacture and supply the alternating current apparatus in the New England States, and also for some 200 local companies which it has already established outside those limits; this will give that company a large amount of additional business in incandescent lighting wherever its arc lighting plants are now in operation. The Westinghouse Company, on the other hand, acquires the right to supply the electric lighting apparatus and introduce and sell the arc light plants of the Thomson-Houston Company on favourable terms all over the United States, and at the same time secures from its competitor the recognition of all its alternating current patents, as well as the payment of substantial royalties thereunder. The Westinghouse alternating current system, although on sale for less than a year, already has in operation over 100,000 central station incandescent lights.

The Water Primary Battery Company.—Says our contemporary *Money* respecting the procedure of this company:—"Mr. D'Humy evidently stands in need of some sound practical advice as to the best methods of inducing the public to believe in what he claims for his water primary battery. For instance, a reference to some fifty or a hundred of these batteries in actual use would obviously have more weight and carry more conviction than one or two merely 'on show' in a factory which, for all practical purposes, means nothing. We shall have something more to say about this wonderful invention later on."

The School of Electrical Engineering.—We hear that at a recent examination conducted by Mr. H. R. Kempe, of the G. P. O., the following students obtained the vellum certificate of this school (*a*) in electric lighting:—G. E. Hartmans with 80 per cent. of the marks; Wm. Green, 78 per cent.; H. R. Braid, 78 per cent. (*b*) In telegraphy and telephony (these students had previously passed in electric lighting):—G. E. Hartmans, 96 per cent.; W. J. Walters, 96 per cent.; J. R. Cotton, 90 per cent.; H. O. Holford, 90 per cent.; P. J. Pringle, 88 per cent. The course of instruction during the first few months has been lately re-organised by the managers, Messrs. Wm. Lant Carpenter and Léon Drugman, with the view of giving greater prominence than heretofore to the mechanical side of the training. The elements of theoretical and practical mechanics are now systematically taught, as well as the principles of machine drawing. More time is likewise devoted to the short course on chemistry. Greater facilities are also given to the advanced classes for lathe and workshop practice under competent supervision.

A Good Test.—The dynamos in the 1,200 light plant in the new Phœnix building, Chicago, were lately subjected to an unusual test by the city electrician. The plant, which consists of three dynamos of 400 lights each, was put in by the Edison Electric Light Company, and guaranteed to stand the severest test ever placed on similar machines. The plant ran—with 25 per cent. of lamps above the normal capacity—continually and with full power for ten hours, and the experiment, which will occasion a stir in electrical circles, proved highly successful.

Dangers of Electric Light Wires.—At Lincoln, Neb., on September 21st, a working man named Smith was horribly mutilated in a remarkable manner. On O Street, at the corner of Ninth, hanging from a telegraph pole and lying along the ground for a distance was a broken telephone wire, which had in some manner become crossed, or in connection with one of the electric light wires. As Smith was passing along the street he saw the wire burning, and attracted by the strange appearance, and not realising what it was, evidently took hold of it to ascertain what it meant. The shock he received was terrific, and his shrieks brought hundreds to the street. He could not loosen his hold on the wire, and it burned his hands to the bone. In his writhings and contortions the charged wire came in contact with his head, burning out one of his eyes and laying the side of his face open. Wherever it struck his body it cut like a knife. A bystander, realising the peril of the man, ran to him, grabbing him to pull him from the wire, but by the shock he received when he came in contact with the body of the man he was knocked 10 feet into the street and utterly prostrated, so that it was feared he was also killed. By this time the electricity had either burned the man Smith loose from the wire or he had succeeded in his struggles in breaking away. He was picked up and carried into an adjoining restaurant and a half dozen physicians summoned. The man presented a horrible appearance, and despite the physicians' efforts to put him under the influence of morphine he shrieked and writhed in the agony he suffered until taken to the hospital. The doctors express the opinion that he may survive his injuries, although it appears impossible.—*Kansas City Journal.*

Torpedoes. — A comprehensive scheme for the defence, by means of torpedoes, of the whole of the seaport towns, naval ports, the entrances to rivers, and other vulnerable portions of the English coast has been ordered to be at once furnished to the Government. The scheme will provide for the raising of a coast defence battalion, composed of regulars, volunteers, and militia, amounting in the aggregate to about 30,000 men. The War Office authorities have entrusted the preparation of the preliminary plans, specifications, and estimate of the probable cost to Captain G. A. Carr, Royal Engineers.

Hedges's Mica Foils.—We are asked to mention that the illustration of the mica foil accompanying our description of Hedges's patent cut-outs is drawn over full size. The new mica foils are made to fit cut-outs having their screw connections either at 26 mm. or 38 mm. apart; but as the slot in the mica foil is wide, a slight divergence in the pitch does not signify.

Gas Explosions.—A gas explosion at a house in Shepherd's Bush Road on Monday caused great damage to the building, and so seriously burnt John Roe that he had to be removed to a hospital.

Another severe explosion of gas occurred on Tuesday evening at Hammersmith, premises being wrecked and a young man so injured that his removal to a hospital was necessary.

On Monday a serious fire was caused in a milliner's shop at Pimlico by a gas explosion.

Multiple Series Condenser.—Mr. Geo. B. Prescott, jun., describes in the *Electrical World* a new adjustable multiple series condenser devised by Mr. William Marshall, a well-known condenser manufacturer in New York.

Electric Lighting in the Streets of Berlin.—At a recent meeting of the Berlin Town Council it was resolved by 91 votes against 3 to light Unter den Linden with 104 arc lamps. Since the imperial residence is situated in that district, the Town Council, as a matter of courtesy, placed the project before the Emperor to obtain his approval, which, says *Industries*, was unhesitatingly given ; but the Emperor doubted that the arrangements of lamps on posts only 26ft. high would effectually light up the statue of Frederick the Great. Dr. Hagen has been commissioned to report upon the proposed illumination, and his report is entirely in favour of it. He is of opinion that the installation will be the most perfect example of street lighting anywhere in the world, the amount of light proposed being largely in excess of usual requirements. Interruption of the light need not be apprehended, as is abundantly proved by the small installation in the Friedrichsstrasse, which has already been at work for three years. After midnight the number of lamps burning will be reduced to 46, and even with this reduced number there will be plenty of light to render the traffic safe. The installation will be erected by the Berlin Electric Works, who have also acquired the central station in the Friedrichsstrasse belonging to the Edison Company, and which is very favourably situated, being near the middle of Unter den Linden. In this station there are four Edison 500-light dynamos, each driven by an Armington-Sims engine. To this plant will now be added some arc light machines. The present network of cables will be joined to the network belonging to the Berlin Electric Works. The Leipzigerstrasse has already for some years been lighted electrically, there being 36 lamps burning with 11 ampères.—The Berlin Electric Works have officially informed the Town Council that they are extending their network within their original district, and that they are ready to go outside their district, provided the Town Council will give them a new concession, in which case they would undertake to erect a new central station in the Spandauerstrasse, to be ready on October 1st, 1889, for the supply of 6,000 16-C.P. lamps. The capacity of this station would, within three years after the opening, be increased yearly by 6,000 lamps, so as to reach in 1892 a total capacity of 24,000 lamps. The company also offer to build, by October 1st, 1890, another central station in Dorotheenstadt, having a capacity of 6,000 lamps to begin with, and increasing this to 12,000 lamps within two years. These offers have been favourably received by the Town Council, who consider electric lighting as conducive to the prosperity of the town.

Electric Lighting by Water Power.—A project for the public supply of electric light to Trient (the principal town in the South of the Tyrol) is now under consideration. Within a mile and a half of the town there are, on about the same level, two cascades of the river Fersina, a tributary of the Etsch, one 23 feet wide with 25 feet fall, and the other 33 feet wide with 40 feet fall. The smaller cascade, says *Industries*, will be utilised to supply water under pressure to the town, a tunnel being at present driven through the rock, the lower end of which will be connected to a system of water mains. The other and larger cascade is to be used for driving a set of turbines, and the motive power will be utilised for working dynamo machines. It is estimated that when the river is high 800 H.P. will be available, and that in dry seasons there will be a minimum of 400 H.P. The town contains 20,000 inhabitants, and the estimated cost of the generating station is £8,500. The water supply under pressure is estimated to cost £12,000.

Electric Lighting of the President's Train.—The special train which is to carry President Cleveland and his party on their western trip is attracting some attention in the States. It is being made ready in the Pullman car shops at Wilmington. The train is composed of three cars, and the third car, which is Mr. Pullman's private car, will be devoted exclusively to the use of President and Mrs. Cleveland. The train will be lighted by electricity. The Electric Accumulator Company has put in storage batteries of 32 cells each under every car, between the floor and the truss rails. The batteries will be charged from a dynamo located in the foremost car, and power to run the dynamo will be derived from the car axle. The lamps and fixtures are of the latest and most approved pattern, and the whole train is a model of comfort.

The Cologne Electric Tramway.—The first trial trip which was recently made in Cologne with the new electric car of Messrs. Huber and Herebrand, of Ehrenfeld, was perfectly successful, reports the Berlin correspondent of *Industries*. The car is in general principles identical with those used in Hamburg, but certain details had to be altered in order to enable the machinery to develop greater power and overcome the difficulty of snow and ice on the road. Current is supplied by E.P.S. accumulators, which the firm manufacture under license from the English company. At the first trial trip everything went well with the exception of the chain brake, which was found to be very unreliable. This circumstance did not, however, prevent the car from being operated in a most satisfactory manner, provision having been made for applying electricity as the brake power. The ordinary brushes on the motor are replaced by contact blocks pressed against the commutator by long springs, and to reverse the motion the position of these blocks need not be altered ; it suffices to reverse the direction of the current through the armature. The controlling switch is so arranged that upon interrupting the current from the accumulators the armature of the motor can be short circuited, by which means the motor begins to act as a generator and to absorb power, thus bringing the car quickly to rest. If it is desired to stop in a still shorter time the current from the accumulators is not interrupted on reversal, and the brake action of the motor becomes still more efficient. Even when used in this way the sparking at the commutator was very trifling.

Electric Lighting.—Tenders are asked for the electric lighting of the main building for the International Exhibition, Glasgow, 1888. General conditions and specifications may be obtained on and after the 24th inst. from Mr. W. M. Cunningham, secretary, 27, St. Vincent Place, Glasgow.

The New Accumulators of MM. Commelin and Desmazures.—This new accumulator, used in the electric submarine boat, is no longer a secret. It contains no lead. The positive plates are porous copper, and the liquid is a solution of zincate of soda mixed with chlorate of soda. The reactions are as follows:—During the charge the electric current decomposes the zincate, zinc is precipitated upon the negative electrode, which is formed of tinned sheet iron, the copper is oxidised and the soda (or potash) remains dissolved in the liquid. There is then a battery of zinc, oxide of copper and soda, such as was proposed by De Lalande and Chaperon. The current utilised during the discharge of the accumulator is supplied by this battery. The positive plates of copper are obtained by submitting pulverulent copper to a pressure of 600—1,200 kilos. per square centimetre. The element is inclosed in a case of tinned sheet iron, the bottom of which supports the negative electrodes. The positive electrodes are enclosed by partitions of parchment paper to prevent the deposition of copper upon the zinc plates. These partitions are kept in their places by upright glass rods. The accumulator, weighing 20 kilos., contains 11 plates, five positive and six negative, of the total weight of 6 kilos. The electromotive force is 1 volt, and the useful potential 0·78 volt during the discharge. Thirty-three kilos. of such an accumulator yield one horse-power. The accumulator of the Electrical Storage Company requires 60 kilos. to store up the same power. The yield in *quantity* seems to be very high, but the yield in *energy* is at most 65 per cent, which is scarcely superior to the results of ordinary accumulators. — *Bulletin International de l'Electricite.*

A New Voltmeter.—Messrs. Siemens and Halske are now introducing a new engine room voltmeter, for which it is claimed that it cannot get out of calibration, as it contains no springs or permanent magnets. The principal parts are a fixed horizontal circular coil, over which is pivoted on knife edges a smaller coil, which, in its zero position, is inclined to the horizontal coil at an angle of about 60°. The coils are so coupled that a current traversing them tends to turn the smaller coil through its vertical position until it becomes parallel to the fixed coil. This tendency is resisted by a small balance weight. The movable coil is provided with a light pointer, indicating the potential on a dial of ground glass. By adopting a transparent scale readings can be taken from either side. The whole instrument is about 6 inches wide by 6 inches deep by 9 inches high, and is exceedingly sensitive. The movable coil contains 800 turns of 2·5 mils. German silver wire, and has a resistance of 34 ohms. The fixed coil contains 1,150 turns of the same wire, and has a resistance of 664 ohms. As at present made the instrument reads with the greatest accuracy from about 60 to 110 volts.

CITY NOTES, REPORTS, MEETINGS, &c.

The Australasian Electric Light, Power and Storage Company, Limited.

THE fifth ordinary general meeting of this company was held on Monday, at Winchester House, Mr. B. H. Van Tromp, chairman, presiding.

The Chairman, in moving the adoption of the report and balance sheet, said they must remember that at the last meeting the arrangement with the Edison Company was confirmed. That arrangement had been carried out; the whole of the assets of that undertaking were transferred to this company, and the consideration which they paid was in shares, and shares only, of this company which bore a dividend—subject, in the first instance, to 1 per cent. to the Australasian Company—on the ordinary capital. In other words, they took a stock which was deferred in relation to the stock of the Australasian Company. Now, what they got for that was the absolute right to the Edison patents in Australasia, in India, and the Cape of Good Hope. They also had a stock of plant amounting to between £4,000 and £5,000, and some book debts amounting to £3,000, upon which they realised something under £2,000. He considered that it was a very good arrangement for this company, because it placed them in a position to command the whole of the market in Australasia and, as far as Edison plant is concerned in India and the Cape of Good Hope also. With regard to the plant taken over, he must confess that the value of it was somewhat illusory; it was somewhat obsolete; but still they thought they would be able to use most of it. They found that the agents who had been acting for the Edison company had been somewhat sleepy; they had to rouse them up. They had appointed a very efficient agent in India, who was making Madras the centre of his operations, and in that district they hoped to see a very good business done. There was a plant in India which could be made available, with some slight improvements and additions sent out from this country. With regard to large lighting operations at the Cape of Good Hope, nothing had been done for some time past. The condition of things at the Cape had been as bad as, if not worse than, in Australia for some years; but with regard to Australia they were in a very good position. They were, as he had said, practically without a rival. The arrangement had caused a good deal of trouble and anxiety to the board before it was carried out, but it was an operation that must eventually redound to the benefit of this company, and he believed also to the Edison company. He would now explain what had become of the capital of their undertaking, and what had been the result of their five years' operations. He thought he should be able to prove that the position of the company is not so bad as it appears to be, on looking at the accounts. The capital of the company was £120,000 only. There were certain shares issued to vendors and certain founders' shares which he need not take into consideration. Practically, all they had to deal with was a sum of £120,000, and what had been done with it? During the first year of the existence of the company no less a sum than £85,000 out of that small capital had absolutely disappeared—£45,000 was paid for patents, and £30,000 in shares, added to that, making £75,000. There was also lost £5,570 upon that unfortunate step, the purchase of the Sellon-Volckmar accumulator option. Then there was the unfortunate Vogel mission, which cost the company over £5,000. The consequence was that, out of their capital of £120,000, £85,000 disappeared without any result whatever, beyond the fact that they were possessed of certain patents which they had purchased from the old Brush company. That was the condition of the capital account. The consequence was that this company had been working with a small sum in ready money. Even if the whole amount had been called up at once, they would only have had £40,000 to work with. He would venture to show that, in meal or in malt, they had that money still. They had only really lost £22,000 on the trading account. He would show them that against that they had fair assets which only require patience and time for realisation. He had put down the assets as follows:—Plant, £15,000 (it ought to be very much more judged by the amounts realised at sales which are daily taking place in Australia), the Australian Company's shares £18,000. When they took shares in that company as part payment for their rights in the City of Melbourne, these shares were at par. In consequence of the great failure in lighting schemes here, these shares fell to 7s. 6d. The last accounts of the company, however, showed a profit, and the shares would very soon reach par. That was an asset which he thought they could ultimately reckon at £18,000; and having regard to the small capital of the Melbourne company, they might reasonably expect that its profits would be increased with the increase of lighting. 5,000 lamps could be lit as cheaply as 3,500 almost; thus the more business they did the larger would be the ratio of profit. Another item was the last call of 10s., which would give net £7,500, which had yet to be realised. If they put these items together, they would find that the assets more than represented the loss that had been made; and therefore there was still a hope that this company might eventually pull round and pay a dividend. He was one of those who thought it might yet do so, and that opinion was shared by others in this room. As regarded their trading the Exhibition had been a great success, and it had spread the fame of the electric light throughout the colony. There would be a profit on that Exhibition he had no doubt, and they would be able to show it in the next balance sheet. At the last meeting the board were urged to see if some new arrangement could not be made whereby the standing charges of this company could be reduced; that was a matter of great and deep interest to the directors. They at once opened up communications with Captain Rowan, in Australia, and pointed out emphatically that important alterations must be made. Capt. Rowan admitted the principle suggested—viz., to be allowed a certain sum for fixed charges and a percentage on receipts and profits, which was to constitute his remuneration for services rendered to the company. He wanted to do a little more than the board could agree to. He wanted the board to undertake a certain volume of work in the colony, either by lighting in the district or by exporting goods, whereby he would have been certain to have made a very handsome income. The board replied that they would fix certain charges which should never be exceeded, and that Captain Rowan's remuneration must be entirely dependent upon results. They found a very great difficulty in coming to an agreement with him by correspondence. At length, most fortunately for the company, in his judgment, Mr. Sanderson, who joined the company a year and a half ago, was going to Australia for the benefit of his health, and he kindly undertook to look thoroughly into this matter with Captain Rowan. Mr. Sanderson took an immensity of trouble, for which he was sure the board were deeply grateful to him. He came back with a certain proposition, and ultimately an agreement was made, but it was only completed and made binding in the month of August last. He very much feared that the accounts for the current year would not greatly be benefited by that arrangement, but for the future it was certain to be a beneficial thing for them. This was the condition of matters with Captain Rowan that the fixed charges should not exceed £682 for twelve months. It would be very hard indeed, therefore, if they could not get sufficient profit to pay that. As regarded the London expenses, they had been reduced. Mr. Duncan gave his own services and those of his own staff, the use of his office, stationery, &c., and the whole expenses did not amount to many hundred pounds. He could not imagine that the business could be carried on effectually in the interests of the shareholders at a less cost than at present. He fancied there was scarcely a gentleman in this room interested in electric lighting but must have been very much delighted to see the enormous progress which was being made throughout the whole of the world during the last twelve months. Imagine the condition of things in America! Upwards of thirty millions sterling had been invested in electric lighting, nearly all the companies paying a dividend. With regard to Europe, he believed that within twelve months there would not be a single theatre in any first-class city that would not be lit with the electric light, which would before long be given to the public at a very cheap rate. Referring to the lecture delivered by Prof. Forbes at the meeting of the British Association, the professor said a thing which, of course, they all knew—that the electric light in this country had been retarded in consequence of the shameful legislation that took place, the object being to protect the gas monopoly against electricity. Everything was done that could be done by the Legislature to stem the current of electricity when it was eager to rush through the country, and would have lighted every town in England but for that fact. If electricity was put on the same terms as gas, in respect to accessibility to all, it could be supplied at the rate of 3s. per 1,000 cubic feet, and show a fair profit to the undertakers. He saw Mr. Ince, the well-known solicitor and electrician, present. He would bear him out that the Grosvenor Gallery Company were now supplying 20,000 lamps in London at a profit, and they would shortly supply more—and this at a distance of four or five miles from the main station. Having a sum of £7,000 or £8,000 at their backs to which they could resort, and having got all their affairs into

order and discipline, he firmly believed that there was a good future still for this company. They could not have to pay more than 10s. upon their shares, and he asked the shareholders to let the board have an opportunity of showing what they could do with it. It was now the opinion of the whole world who thought upon such matters, that the electric light was the light of the future. And ever since he saw the electric railway at the Crystal Palace he believed it would be the great motive power of the world. The electric light was most extensively used in Vienna, Genoa, Padua, Milan, Paris; and in St. Petersburg every theatre except one was closed, pending improvements in egress and the introduction of the electric light. He begged to move the adoption of the report and accounts.

Mr. J. J. Cater seconded the motion.

Mr. Ince said that every shareholder must feel with the board that the future of this company must be a success. The directors ought to look forward to increasing their capital by 10 per cent. He was a large shareholder, and if the directors increased the capital he would be ready with his 10 per cent. He maintained that £20,000 could be profitably invested in the colony to-morrow. He believed the electric light, even at its present price, was going to stamp out gas as an illuminant; it was already cheaper than any gas supplied in the City of London.

Mr. Verity thought the company ought to be a selling company and not a lighting company. The Edison and Swan Companies were giving up installations, and selling lamps and dynamos.

A Shareholder: Are not some of the shares fully paid already.

The Chairman: As regards the capital of £120,000, none of these shares are paid up in full.

Mr. Macmillan hoped the shareholders would support the board in any increase of capital.

Mr. Sanderson, at the request of the Chairman, gave an account of his negotiations with Captain Rowan, being the only member of the board who had seen that gentleman. He had great satisfaction in telling them that they could not be represented by a better man, taking him all round. He was a retired captain in the army; perhaps his education would hardly qualify him to become a good accountant, but with that exception he was a first-rate man to push. Great praise was due to Mr. Duncan for giving him (Mr. Sanderson) such exhaustive instructions, as it enabled him to feel *au fait* in all the intricacies of the company's business. He found that the lighting of the theatres and other installations gave great satisfaction to the customers. He thought they ought to foster the lighting station as much as possible in view of the large stake they held in the Australian Company.

The Chairman, in reply to Mr. Verity, said the principal profit they had made in Australia had been from plant, such as dynamos, which they had sent out, and upon which they had made an extremely handsome profit. The whole of the profit they made last year was made out of the goods exported to Australia, and the orders resulting. If electricity had preceded gas the electric light would have been in every town in the kingdom long ago. But the gas monopoly was breaking down. In the City of Christiania the Corporation were the owners of the gas works, and they had determined to abandon gas, and provide their own plant to light the city with the electric light, retaining gas only for cooking and heating purposes. The town of Leamington had also recently decided to abandon gas.

The motion for the adoption of the report and accounts was then unanimously agreed to; the retiring directors, Messrs. Latimer Clark and Philip Falk, were re-elected; the auditors, Messrs. Deloitte, Dever & Co., were re-appointed, and a vote of thanks was passed to the chairman.

The meeting then terminated.

Water Primary Battery Company.

From the "Financial News"

THE ELECTRIC LIGHT AT THE PRICE OF GAS—BRILLIANT HOPES HELD OUT.

THE ordinary general meeting of the Water Primary Battery Company, Limited, was held on the 13th inst. at 265, Gresham House, Broad Street, E.C., Colonel G. B. Malleson, C.S.I., presiding.

The notice convening the meeting having been read by Mr. W. H. Smith,

The Chairman said: Gentlemen, I have very great pleasure in introducing to you the inventor of the water battery, Mr. d'Humy, who is a very old friend of mine, for I have known him many years, and know he is a gentleman who possesses one of the most inventive minds in Europe. No single invention of his have I seen which is not capable of practical application. With regard to this water primary battery I have taken various engineers of my acquaintance to the office with the express idea on my part that they should be able to pick a hole in it; but not one of them has succeeded in that. Gentlemen, with these few remarks, I shall call on Mr. d'Humy to address you on the points which he may consider necessary.

Mons. P. R. de Faucheux d'Humy said he would do his best to give as clear an explanation as possible. Last year, on December 23rd, he formed a company with a capital of £100,000 in fully paid-up shares, £20,000 being given to him as the vendor, as well as the shares in payment for all plant, machinery, and stock, and also for the English, French, American, Indian, Belgian, Austrian and Italian patents of the water primary battery. He started the company without calling any capital from the public, and to show his confidence in the invention he had paid all the expenses up to now to bring the company to its present success, and he had acted as an ordinary traveller, instead of the managing director of the company, in trying to obtain orders. Since December 23rd he had manufactured a big battery, to be demonstrated at 26, Gray's Inn Road, as a specimen of a central station battery for lighting a number of houses. For ten months this battery had been going day and night, and he had invited the public and all the scientific world of Europe to visit the place and inspect it. For ten months it had been working with no need for repair. The invention had made some sensation in Europe. Municipalities and Governments had sent their engineers and confidential men to report on it, and it had given satisfaction to everybody. It had been proved that the battery could be worked as well as the dynamo, and that a large field was open to it for supplying electric light. He had succeeded in obtaining very important concessions for it in various big cities, and on September 16th last he had obtained a concession for lighting Madrid by electricity—and about 200,000 lamps would be required within the next four years—and had given the contract for the execution of the said work to the Water Primary Battery Company, Limited. Official document and decree were now before the chairman. He had sold the patent for France for £100,000, which was to be paid by a syndicate, according to French law—that was to say, a fourth of the amount would be paid almost immediately. Since he sold the French patent he had received a letter from France telling him that the syndicate were obtaining orders very rapidly. This company would be the contractors for the French company, supplying all the water battery appliances, and the transaction would be very profitable. This company, he pointed out, had started with no capital, and their manager had never received a salary, but, working as an ordinary clerk, he had succeeded in making a very good report and was able to say that next year on the original capital of £100,000, the shareholders would receive a dividend of about 100 per cent. For years he had carried on a fight with engineers and scientific men of Europe. Nobody would believe that from water the power to light by electricity could be obtained; but he had proved that with water and a metal that did not destroy—that was to say, with common iron plunged in water—he could obtain a result that was reputed in the scientific world to be impossible. Every week for ten months he had had 600 or 700 people at his office to inspect the invention, and he had shown to the engineer how to distribute the electric current with no mechanical difficulty, and proved to the uninitiated on the subject how he could manufacture his own electricity at his home. Lately he had made another invention, which would, he was sure, be very popular in all Europe, and he had been offered £30,000 for the patent in France. It was a very small battery, and he had received applications for it in reference to one, two, three, four, and ten lamp-power for lighting very small houses and small workshops. He had given a long course of study to the subject, and to-day the invention was complete. It consisted of a little battery which was automatic, and capable of working for many years. The problem had been solved with the water battery, and the two inventions had become very popular in the world. He had established the water battery in the confidence of contractors in the North of England, and had succeeded in getting a staff ready to manufacture the water battery and the small battery on a large scale. The company possessed in the North of England a very large amount of business, and had made a contract with an important firm for the manufacture of both batteries, viz., with Messrs. J. Butler & Co., of Stanningley, near Leeds, who had so much confidence in the future of the invention that they had not hesitated to take shares and debentures as the consideration, so that for the present this company was in a position to form several large centres without expending a single shilling. Propositions had also been made by another important contractor who was desirous of joining the contractors in the North and working with them, and had offered a large sum of money to enter into the concern. This, he thought, was all he had to explain.

Mr. W. H. Smith asked Mr. d'Humy to give some further explanation as to the concession at Madrid.

Mr. d'Humy said that concession did not belong to this company, but to him personally; but he had transferred the work, under contract, to the company, and they would make a large profit out of it—£25,000 or £30,000. He was also negotiating for the sale of the patent at Belgium, Austria, America, and other countries, and these sales would also bring some important profits to this company.

The Chairman said it had occurred to him while Mr. d'Humy had been speaking that the success of every enterprise depended on the fact that the basis of it was sound and valid. He did not know whether all the gentlemen present had seen the water battery at work, as he had, but if anyone had the slightest doubt of the validity and value of the machine, and its ability to effect what Mr. d'Humy said it could, let him put any questions to that gentleman, and he would, no doubt, answer to his own satisfaction and to the satisfaction of them all.

Colonel Innes said he did not profess to know anything about electricity, but some months ago he made an examination of the invention, and was very pleased with everything he saw. But in making inquiries in reference to the lighting of the Cheshan Gallery, Old Bond Street, he went to three or four firms, and, in discussing this company's invention, one man, a thorough electrician, declared the plates would never last. He should like some explanation on this point.

Mr. d'Humy said in the water battery there were two kinds of plates—one iron, the other carbon; the objection referred to

the carbon plate. Undoubtedly if there were any silica in the carbon plate it would perish, but in his invention there was no silica, but pure carbon, and therefore it was indestructible.

Mr. Dawson Philpot said when he had denied that there was any decomposition of metal, he was met with the reply that in that case there could be no light.

Mr. d'Humy said instead of a decomposition of metal there was a decomposition of nitric acid, which was enclosed in a reservoir in the machine. A pound of nitric acid cost 2d., and would produce light for 15 lamps of 10 candle-power each.

Mr. Oxley raised a question as to the business now in hand, in reply to which,

Mr. W. L. Maitland stated that he had had the business of the company in hand only a little over a week, and in that time he had obtained for Mr. d'Humy close on £15,000 worth of orders. His fear was that they would not be able to supply all the customers he could bring them.

A Shareholder: The orders are chiefly to do with theatres, I think?

Mr. Maitland: Yes, and other large buildings. Two large contracts have been closed, and two will be closed within a week, and two others also within a week, for large stores.

The Chairman: That is very satisfactory; but it will be still more satisfactory if Mr. d'Humy tells us he will be able to supply all orders rapidly.

Mr. d'Humy: Oh, yes; we have the contractor in this room—Mr. Butler—who has more than 1,000 men at work in his factory, and will be able to manufacture very rapidly so as to supply the demand.

The Chairman said it had been suggested to him that Mr. d'Humy should explain to the meeting the working of the battery; but his answer to that was it would be far better if gentlemen who had not seen the works should go and see them. He was sure Mr. d'Humy would explain on the spot the mode of working and the principle on which the work was carried out.

Mr. d'Humy: With the greatest pleasure. Replying to a question as to the price of the light supplied by the company, Mr. d'Humy said the battery would supply the light at exactly the price of gas. If the company only supplied the light it would leave them a small profit, but it would be quite the exception that they supplied the light without the battery. For a very small installation the cost would be 10 or 15 per cent. above the price of gas.

Mr. W. H. Smith moved a vote of thanks to the chairman for his kindness in attending the meeting. He knew Colonel Malleson's engagements were such that it was very difficult to get hold of him; but they also knew that he was always ready to help on any scientific object, for the benefit of the world in general.

The Chairman said he thought their thanks were due rather to Mr. d'Humy for the explanation he had given. He thought they must have been struck with wonder and admiration at the ease with which the light could be produced under the company's system, and which when produced by the ordinary way of dynamo, caused great disturbance in private houses, and a great deal of unpleasant noise in larger premises. He was sure that those who went to see the battery would go away with wonder at what science could do, especially in the hands of such a skilful man as his friend Mr. d'Humy.

The proceedings then closed.

[We are asked by Mr. d'Humy to state that the company has secured the lease of the site known as Ship Court, 36, York Street, Westminster, for 42 years, where a large central station will be erected for lighting by electricity the mansions and buildings in Victoria Street, Westminster, and in Pimlico.]

Eastern Extension, Australasia, and China Telegraph Company, Limited.

THE report for the half-year ended June 30th, states that the gross receipts, inclusive of Government subsidies, have amounted during that period to £219,201 4s. 8d., against £224,843 0s. 1d. for the corresponding half-year of 1886.

The working and other expenses, including £26,408 9s. 7d. for cost of repairs to cables and expenses of ships, absorb £76,241 3s. 6d. against £81,775 7s. 1d. for the corresponding half-year of 1886, leaving a balance of £142,960 1s. 2d. From this is deducted £3,702 16s. 5d. for income-tax, and £41,595 for interest on debentures and contributions to sinking funds, leaving £97,662 4s. 9d. as the net profit for the half-year, against £97,480 5s. 8d. for the corresponding period of 1886.

One quarterly interim dividend of 1¼ per cent., amounting to £31,250, has been paid during the half-year and another of like amount was distributed on the 15th instant, leaving £35,162 4s. 9d. to be carried forward.

In accordance with the provisions of the trust deed, dated 10th May, 1879, 264 5 per cent. Australian Government subsidy debentures were drawn on the 29th April last, for payment at par on the 1st July.

The company's maintenance ships have been kept employed on various cable repairs during the half-year under review, but no interruptions of a serious nature have occurred.

The company's hulk *Southern Ocean* stationed at Singapore during the last eight years, having been reported to be unsafe as a floating cable establishment in consequence of ravages of white ants, the vessel has been dismantled, and the machinery and cable tanks removed therefrom to the company's new shore cable establishment at Singapore. The hulk has since been sold by public auction.

The subject of reduced tariffs between Europe and the Australasian Colonies was discussed at the Colonial Conference recently held in London, and the proposals submitted by the Company based upon a Colonial guarantee or subsidy are now before the Colonial Governments.

The South Australian Government land line between Port Darwin and Adelaide has, as usual, been satisfactorily maintained during the half-year under review.

Anglo-American Telegraph Company, Limited.—The directors have resolved to declare an interim dividend for the quarter ending September 30th, 1887, of 7s. 6d. per cent. on the ordinary stock and 15s. per cent. on the preferred stock, less income tax, payable on November 1st to the stockholders registered on the books of the company on October 7th, 1887.

Consolidated Telephone Construction and Maintenance Company, Limited.—The directors have resolved to pay an interim dividend at the rate of 5 per cent. per annum in respect of the current year, payable on and after November 5th.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 14th were £2,752, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th October are £2,629, as compared with £1,863 in the corresponding period of 1886.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended October 14th amounted to £3,365.

NEW PATENTS—1887.

13519. "Insulators for electric conductors." R. C. DOUGLAS. Dated October 6th.

13558. "Electrical apparatus." P. EVERITT, P. R. ALLEN. Dated October 6.

13561. "Electricity meters." H. W. KOLLE. Dated October 6.

13567. "Automatic electrical firing mechanism for naval ordnance." A. M. CLARK. (Communicated by P. Oriolle.) Dated October 6.

13601. "Automatic coin-worked and other electrical machines; displaying advertisements therein." J. H. DAVIES. A. THOMPSON. Dated October 7.

13610. "Electrical keys for firing guns." J. L. CLARK. Dated October 7.

13637. "Telephonic apparatus." H. F. JACKSON, D. SINCLAIR. Dated October 8.

13641. "Voltaic or electric batteries." T. and H. V. COAD. Dated October 8.

13720. "Effecting electrical measurements and contacts." A. DE KHOTINSKY. Dated October 10.

13722. "Electrical secondary batteries." C. E. PONDER and OTHERS. Dated October 10. (*Complete.*)

13736. "Electric spinning and twisting machines." A. S. KIMBALL, G. L. BROWNELL. Dated October 21. (*Complete.*)

13754. "Compensating post office resistance boxes for changes of temperature." H. L. CALLENDAR. Dated October 11.

13758. "Electrical apparatus for use in dental operations, &c." A. J. BOULT. (Communicated by Smith and Kimble.) Dated October 11. (*Complete.*)

13767. "Adapting electricity to automatic apparatus for holding goods to be sold until contact is made by any suitable coin." A. W. ARMSTRONG, B. W. WARWICK. Dated October 11.

13766. "Adapting electricity to automatic advertisement to reflect rays of light." A. W. ARMSTRONG. Dated October 11.

13778. "Automatic electric signalling for railways." W. WALKER. Dated October 11. (*Complete.*)

13805. "Electric batteries." H. M. MUSGROVE [NORMAN AND SON], H. LYON. Dated October 12.

13821. "Electrical switch." J. R. H. WILLIAMSON, MANCHESTER DISTRICT EDISON LIGHT COMPANY. Dated October 12.

13848. "Procuring flames by means of electricity." T. E. FRANCIS. Dated October 13.

13853. "Telegraphic apparatus for transmitting orders, replies, &c., in steamships, buildings, &c." G. A. CALVERT. Dated October 13.

13864. "Incandescent electric lamp-holders, &c." F. H. ROYCE. Dated October 13. (*Complete.*)

13884. "Bullet extractor (electrical)." A. M. GORDON. Dated October 13.

13890. "Electric batteries." D. URQUHART. Dated October 13.

13903. "Thermo-electric generators." R. KENNEDY. Dated October 13.

13953. "Electro-motors." D. T. PIOT. Dated October 14.

13954. "Closed conduits of elastic, &c., material which will admit of the opening or closing of an electric circuit on pressure or release from pressure in combination with circuit closing rails for communicating electrically with railway cars, &c., for propelling them through the agency of electric motors or operating any electrical machine, &c., for lighting, braking, heating, &c." W. E. IRISH. Dated October 14. (*Complete.*)

13959. "Telegraph form books." A. SLOAN. Dated October 14.

13960. "Combination of spring-jack and lightning arrester for use in or with a test board for telephones wires and carrying and arranging any required number of sets or apparatus formed of such combination." A. COLEMAN, H. F. JACKSON. Dated October 14.

13967. "Brushes and their holders for dynamo-electric generators." W. T. GOOLDEN, A. P. TROTTER. Dated October 14.

13970. "Automatically administering medical electricity to the human frame, also applicable for other purposes." M. NIGHTINGALE. Dated October 14.

13974. "Electric alarm for varying levels and pressures." A. SIEGMANN. (Communicated by C. Marohn.) Dated October 14. (*Complete.*)

13978. "Electric firing gear for rapid firing and other guns." A. NOBLE. Dated October 14.

13994. "Regulators for electric arc lamps." W. BRIERLEY. (Communicated by E. Pabst.) Dated October 15.

14012. "Partitions and porous cells of electric piles." W. P. THOMPSON. (Communicated by H. E. de Rufz.) Dated October 15.

14015 "Electrically lighting miners' safety lamps whilst locked; lighting other lamps." C. AUTY. Dated October 15.

14024. "Secondary batteries or electrical accumulators." N. DE BERNARDOS. Dated October 15.

14054. "Electro-chemical process for the extraction of the precious metals from their ores." D. G. FITZGERALD. Dated October 17.

14062. "Automatic medical electrical apparatus." E. PULLAR. Dated October 17.

14063. "Self-contained electrical firing projectile." D. BOYD. Dated October 17.

14107. "Continuous current commutatorless dynamo." N. G. THOMPSON. Dated October 18.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

9313. "Improved arrangement for applying electro-motors to vehicles." W. L. HOLT and M. IMMISCH. Dated July 17. 11d. The inventors mount the motor so that it is supported by, and consequently follows the movement of any vibrations to which the axle of the driving wheels may be subjected, quite independent of the movement of the vehicle in relation to the driving wheel axle or axles. The claims are 7 in number.

9432. "Improvements in the process for treating auriferous substances by electrolysis." H. LIEPMANN. Dated July 20. 8d. Claims:—1. In an apparatus for separating metals from ores or alloys by electrolysis, the combination of an anode compartment, a cathode compartment, a filtering diaphragm, as described, separating said compartments, a dense porous diaphragm for separating said compartments during one step of the operation, and mechanism whereby the dense porous diaphragm may be placed in apposition with or removed from the opening between the anode and cathode apartments, substantially as described. 2. In an apparatus for separating metals from ores or alloys by electrolysis, the combination with a journalled drum constituting the anode compartment, of a trunnion constituting the cathode compartment, said drum having an opening at its end into said trunnion, a movable porous diaphragm for closing said opening, an adjustable screw-rod to which said diaphragm is attached, and supports within the trunnion for said screw-rod, substantially as described.

10499. "Improvements in telegraph keys." J. M. BIGGS. Dated August 16. 8d. Consists of a key having short and long arms, the short arm being provided with a finger piece, the longer arm carrying a contact point, and in the combination with the key arranged in this manner, of a switch and conductor for conveying the current from the switch to the stationary contact point of the key. The claims are 4 in number.

10620. "An improved machine for automatically administrating an electric current." W. S. OLIVER. Dated August 19. 6d. Claim: The improved machine for automatically administering an electric current to a person standing on the platform or other portion of the machine, said machine being rendered workable by the dropping in of a coin as described.

10715. "A permanent self-locking insulator with a notched device to render it impossible for the conductor to slip or come out of its bearings when once fixed in position." H. FURSE and H. THOMLINSON. Dated August 21. 6d. Consists of a base-plate of any material or shape (insulating for electrical purposes) provided with a boss of convenient size, in which is made a "bayonet notch" tapering off to a slot. There are 4 claims.

10765. "Improvements in secondary generators for the conversion of electrical energy by induction." W. LOWRIE, C. J. HALL. Dated August 23. 11d. The inventors form two cores of thin iron plates, each iron plate being separately insulated from the rest to prevent Foucault currents. On each of these cores a primary and scondary coil is wound, part of the core projecting beyond the coils at both ends. The coils are then placed side by side and the plates of the projecting cores are turned over alternately, each pair of plates forming a closed magnetic circuit insulated from the rest. The whole of the plates are then clamped tightly together at both ends to ensure good magnetic contacts. Any number of these couples may be employed, and their coils connected in series or divided into sections and connected parallel to suit the conversion required. The iron cores can be made of such dimensions that the required length of wire can be wound thereon two deep, one layer forming the primary and the other the secondary coil, or it may be wound one deep, so that the convolutions are alternately primary and secondary. Thus all the wire being in such close proximity to the iron great efficiency is obtained and the wires with the greatest difference of potential are the farthest apart, this being a great advantage where high tension is employed, large heat radiating surface is also obtained. The claims are 12 in number.

11139. "Improvements in glow lamps." C. SEEL. Dated September 1. 8d. Claims:—1. The employment of several carbon threads which are connected with one another by means of a thickened centre-piece, and the ends of which are connected with separated contacts, for the purpose as described. 2. The employment of a hollow empty shell provided with air holes in combination with platina wires which pass free through this shell, for the purpose described.

CORRESPONDENCE.

A Need of the Age.

I have read your article discussing the question of the formation of an electrical association on similar lines to the National Electric Light Association of America, which, judging from the papers read at the recent meeting, appears to be in a most vigorous condition. I very much doubt if a new electrical section would be entertained by the general committee of the British Association; as matters are, there is too much of the "picnic air" about the B.A. meeting; good papers are hurried through because the sections close at three o'clock, and a discussion is impossible. It appears to me that in the Society of Telegraph-Engineers we have all the necessary machinery ready to hand, and a convention might be arranged very much in the same way as the Institution of Mechanical Engineers holds its summer meeting in different towns each year. The animadversive remarks which have been made against the society in the matter of the "rules" for the prevention of fire risks appear to be very unreasonable; the society has, perhaps, been rather dilatory in revising its rules, but I understand that the committee have commenced the work of revision, and should have the support of all electric light engineers who wish their work to be untrammelled with too hastily-drawn regulations. I can find no truth in the report that the insurance companies are about to adopt the Phœnix rules, to the exclusion of those of the society; on the contrary, I have had occasion lately to correspond with two of the oldest and best known insurance offices, who have sent me copies of the Telegraph-Engineers' rules, stating that "they use these," but "also inspect electric light installations with their own surveyor, and are guided by his report." Plain and concise rules are particularly necessary for work in the Colonies. Since writing to you in January last about India, I understand that the American insurance regulations have been found the most suitable, as the installations will probably be carried out on lines somewhat similar to those in the western cities of the United States.

Killingworth Hedges.

October 18th, 1887.

The Water Primary Battery.

As a constant reader of your interesting and valuable journal, I beg to enclose a report of the "D'Humy" battery which recently appeared in the *Financial News*, but which you have possibly already seen.

I should much like to see an exhaustive discussion in your columns on the merits and de-merits of this "réchauffé" cell, many of my friends interested in the lighting of my house (gas engine, dynamo, and E.P.S. cells) being anxious to know something about this D'Humy battery.

S. L. Cocks.

October 19*th*, 1887.

Last week we received the following letter :—

[COPY.]

"Gresham House, Old Broad Street,
"London, *August* 12*th*, 1887.

"Gentlemen,—We have received instructions from our client Mr. D'Humy to at once commence proceedings against you for damages for libels contained in the ELECTRICAL REVIEW against him and would be glad by you furnishing us with the names of your solicitors. Yours truly,

"W. H. SMITH & SON."

To this we replied in the terms given below :—

[COPY.]

"*October* 13*th*, 1887.

"Gentlemen,—We are in receipt of your letter of the 12th inst., and will in due course grant your request, but before doing so will be pleased if you will point out to us in our publication, the ELECTRICAL REVIEW, the passages of which you, for your client, complain.

"Yours truly,

"H. ALABASTER, GATEHOUSE & CO.
"Proprietors of the 'Electrical Review.'"

[Up to the time of going to press we have had no further communication from Messrs. Smith & Son, but we have indulged in another "reverie."—EDS. ELEC. REV.]

Melting Copper Wire.

It would greatly oblige another correspondent who labours under the same disadvantage of lack of instruments, if the table of ampères required to melt copper wire or to ignite a certain length of iron wire, could be extended so as to indicate what would be the heating effect of a current of 100, 250, and 500 ampères upon either copper or iron wire of the requisite diameter.

Amateur.

Who Can Tell?

I shall be obliged if you can enlighten me as to whether it is permissible under the rules of the City and Guild Technical Institute, to convert the class rooms of the Finsbury Technical College into advertising stations? If so, I (in common with other business men) shall be glad to learn their terms for spaces for wall cases, similar to the one now on exhibition there. I enclose my card, and remain

A Would-be Advertiser.

October 17*th*, 1887.

Edison's Mystery.

Mr. Edison appears to be setting all the world thinking and worrying as to what his new adventure is to be.

Anyone watching his recent investigations and experiments in pyro-magnetic electricity can give a tolerably shrewd guess as to what he is going to do. My idea is that he probably intends to "utilise the waste heat of the kitchen-stove" to generate currents of electricity for domestic purposes; or that he intends to go into the bowels of the earth for his power by utilising the natural gases and carburetted hydrogen now going to waste in so many of the American coal-mines, adapting same to drive his new pyro machine so as to light the mines by electricity at the pit's-mouth, and probably also to light the surrounding towns of the colliery district by the aid of Nature's power now going entirely to waste (although worth millions), and ample to produce 1,000,000 H.P. annually by being converted into steam and used to drive the required machinery.

Mr. Edison evidently has an eye to business, well knowing that it is cheaper to convey the E.M.F. through a wire to the required district than to convey the coals by carriage for the same purpose. Probably his transforming system, as described in the last issue of the ELECTRICAL REVIEW, is destined to play an important part in carrying out the objects he has in view. It is rumoured in Paris that Rothschild's idea is to generate electricity in the colliery districts, so probably Mr. Marcel Deprez and Mr. Edison are working hand in hand together to light either Lille or Paris by Edison's electric lamps through the aid and combination of pyro-magnetised natural gas to generate the current.

I am not an inventor, a bibliophile, or even a thermo-pile, so will for this purpose subscribe myself under my old "nom-de-plume,"

Filacer-Filacium.

An Electrical Association.

I notice with interest that the question of an electrical association has been again brought forward. I regret that I have not by me the correspondence now passing on the subject in some of the technical papers, but I wish to take this opportunity before another week goes by of saying that I should personally be extremely glad to see a strong electrical association brought into existence, and I think that the action which my firm took rather more than twelve months ago in this matter, associated as we then were with several of the leading electrical firms, is sufficient proof that any such association as the above, if started upon sufficiently broad and impersonal lines, would be sure to be strongly supported. I shall be glad to see from your columns or from those of your contemporaries, what further action is being taken, as I think that now is a most favourable time for the matter to be pushed forward. I have expressed my opinion personally, as I believe that a large consensus of personal opinion is the first necessary step.

J. F. Albright.

October 17*th*, 1887.

In your last issue you refer to a movement for the establishment of an association for the advancement of the electrical industry. One need hardly bring proofs of the need of an organisation of this kind, sufficient proof being the evidence of the number of attempts that have been made during the last five years by those interested in electrical work to form an organisation to forward their interests. These attempts have up to the present failed, chiefly, I believe, for two reasons; first, that they were not universal enough, but confined to a few leading firms; secondly, that the details were not sufficiently thought out. There is no doubt in my mind that if we are to have an association with such recognised status that it can bring pressure to bear upon Parliament, and that its membership or certificate may be an honourable distinction and not the mere matter of payment of a fee, it must be an association supported by all, carefully thought out, and with a properly-formed organisation and a proper and efficient staff. As yet the whole scheme is floating in the air and needs a definite shape. I would suggest that the

matter be taken up by someone known to be unbiassed, say, the representatives of the technical press, that a meeting of those interested in electricity be called at the Cannon Street Hotel, and that after discussing the matter a representative committee be elected to draw up a report to be published and laid before a subsequent general meeting, showing the different methods in which the scheme might be carried out, and pointing out their relative advantages and disadvantages. At this subsequent meeting the scheme might be settled upon, and a permanent committee appointed, in which all degrees of those interested should be fairly represented, and a definite line of policy laid down, so that one might have an opportunity of seeing whether it is worth while joining it.

In conclusion, I may give a list of points, a few of which it may be worth while for the association to take up :—

1. To bring pressure on Parliament in such matters as lighting and tramway Acts.
2. To remove legal restrictions and obstacles to the growth of the industry generally.
3. To aid in the opposition to vested interests where opposed to electrical work.
4. To establish public confidence, especially in the financial and commercial world.
5. As far as possible, by inspection or otherwise, to compel firms to do good work.
6. To approve of articles and methods (Hall mark.)
7. Maintenance of prices at a fair level.
8. To act as a recognised authority for tests.
9. The conferring of certificates both upon individuals and upon articles.
10. The comparison (wire guages), issuing and certifying of standards.
11. The minimising of, and dealing with, fire and life risks.
12. Registration of applicants for employment.
13. Registration of "black sheep."
14. Protection of the trade financially.
15. Stamping out of blackmailing and similar systems.
16. Arbitration between firms and individuals.
17. To give opportunities for conferring together on the above subjects.

F. L. Rawson.

Telephones not Patented.

When I replied to the letter of Mr. Ross, I did not for a moment think that I was to be led into a controversy ; my sole object was to set forth what I believe to be facts touching the Bell patents. As my previous statements have been called in question by Mr. Ross in his letter in the REVIEW of September 12th, I content myself with a few words in reply, and shall refer to the proof of my statements. In the first place, in Bell's English patent of December 9th, 1876, there is no description of the "English Mechanic," nor any drawing representing such an instrument. Hence it is evident that such an instrument, not being described nor claimed in a patent, could not be subject matter of a disclaimer. Mr. Bell's patent, fig. 19, representing a cone having a *stretched membrane* over one end of it, is the only one in which mention is made of a *stretched membrane* with one end of an armature attached to the centre ; the other end attached to the uncovered leg of an electro-magnet. In the memorandum of disclaimer, 4th edition, page 2, lines 1 to 6, are to be found the following words :—"And whereas, I am desirous for the above reason of *confirming* my claims in the said specification to arrangements of telephonic apparatus wherein are employed plate armatures, or armatures other than *those carried by a membrane*."

The instrument described and shown as fig. 19 in the English patent was described and shown in Bell's U.S. patent of March 7th, 1876, which was published in the Official Gazette of the U.S. Patent Office of March 7th, 1876, and said Gazette was on file in the British Patent Office on July 3rd, 1876, and this was the *prior* publication of part of Bell's English specification which necessitated the disclaimer.

Mr. Ross should not allow his confessed ignorance on American patents to lead him to doubt the facts stated by me without making inquiries. He will find, in the library of the Patent Office, the Official Gazette above referred to, and therein he will learn that Bell's patent of March 7th, 1876, did contain fig. 19 with the *stretched membrane*. In the disclaimer, 4th edition, page 10, lines 5 to 7, will be found the following words :—"It is to be noted that *no claim* is made to the use of telephonic apparatus wherein a *membrane* like goldbeater's skin is used." Now the only mention in Bell's original specification of a membrane is that referring to fig. 19. In reply to that part of Mr. Ross's letter in which he cites the fact that the description of the instrument, fig. 19, described by me, and alleged by me to be the subject matter of the disclaimer, is contained in the amended specification of Bell, dated February 13th, 1878. I will only refer to the following words in the disclaimer, on 10th page, under the head "Fourth Plan," "which is not *claimed further* than is indicated by the *claims* made in the *claiming* clauses hereto annexed ; and it is to be noted that *no claim* is made to the use of telephonic apparatus wherein a *membrane* like goldbeater's skin is used."

There is no *claim* for any such device in the disclaimer ; hence Mr. Ross is in error in supposing that Bell has not disclaimed fig. 19.

The E. M. T. was not described in Bell's patent. It differs from the fig. 19, which latter was described and disclaimed. I cannot conceive how Mr. Ross could imagine that I wrote that there was a *British* patent containing such a claim on file on July 3rd, 1876.

My language was very clear that the Official Gazette of U.S. Patent Office containing Bell's U.S. patent of March 7th, 1876, was on file on July 3rd, 1876, in the British Patent Office, which fact constituted a publication of it.

W. C. Barney.

New York, *October 7th*, 1887.

Underground Wires.

In his second letter in last week's REVIEW your correspondent "W." concludes by saying :—"As to the Edison tubes referred to by Mr. Callender, I remember that some three or four years ago the failure of this system in New York city caused considerable inconvenience. I must admit, however, that I do not exactly know what improvements have been made since that date."

With regard to the last sentence, I think it just possible that "W." may not have heard the discussion which took place on Prof. George Forbes's interesting paper on "Underground Wires," recently read before Section G of the British Association. It was duly reported in the ELECTRICAL REVIEW of the 16th ult.

In this discussion Mr. Upton described the Edison system up to date, amongst other things.

In case "W." was not present at the meeting or has not seen your report thereon, I thought it might be worth while calling attention to it.

Charles Bright, jun.

October 17th, 1887.

Simple Needle Duplexing.

Can you or any of your numerous correspondents tell me how the single needle duplexing, of which we heard so much from Scotland a few months ago, is progressing. If sufficiently well to warrant its continued use and extension, the fact is surely worth making known to all the world through the medium of the REVIEW, so that the principle of the invention may be fully enquired into and its advantages made use of by those who may be favourably impressed.

A Subscriber.

October 15th, 1887.